COMPLETION OF THE PENNSYLVANIA R.R. EXTENSION AT NEW YORK

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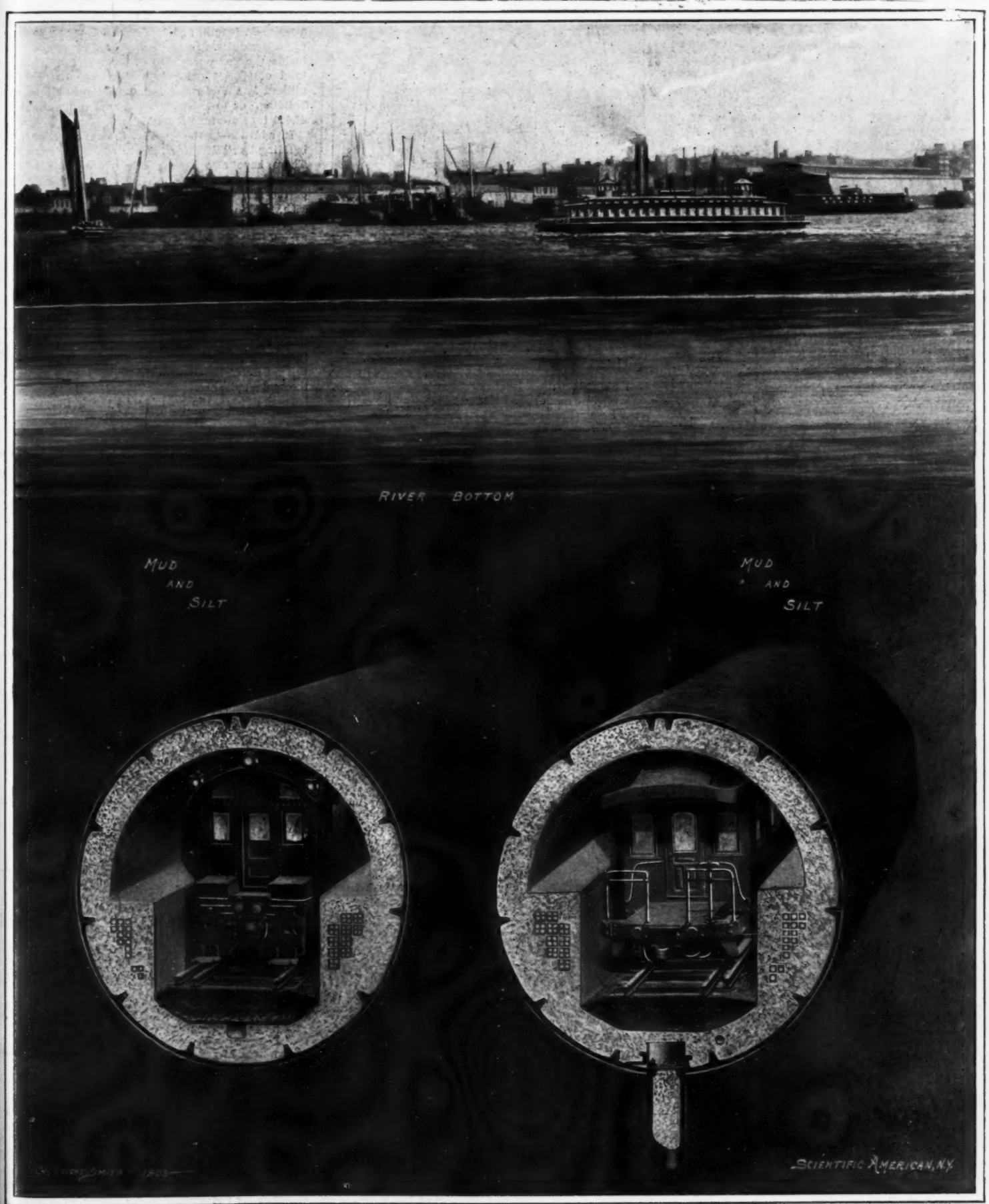


Total length of tunnel from New Jersey to Long Island, six miles. Outside diameter of shell, 23 feet.

SECTIONAL VIEW OF PENNSYLVANIA RAILROAD TUNNEL NOW UNDER CONSTRUCTION BENEATH THE HUDSON RIVER.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

THIS issue of the SCIENTIFIC AMERICAN SUPPLEMENT is intended to describe briefly what is known as the New York Tunnel Extension of the Pennsylvania Railroad, the costliest improvement ever made by a railroad company and one of the most far reaching importance to industry and to the traveler.

The New York Tunnel Extension of the Pennsylvania Railroad begins at Harrison, N. J., a few hundred yards east of Newark, N. J. It is at this point that through passenger trains from southern and western points are to change their steam power for electricity. At Harrison there are transfer platforms for passengers, a car yard, and a yard for the huge electric locomotives used in the tunnels.

Through trains for New York leave Harrison on rails crossing over the old Pennsylvania tracks on a tremendous concrete bridge. A double-track line on a high embankment extends across the marshy Hackensack Meadows to Bergen Hill, that high eminence which is a continuation of the rocky cliffs extending along the Hudson River. At this hill are found the entrances to the tunnels which lead under the North River, into the station in New York, and then on to Long Island City.

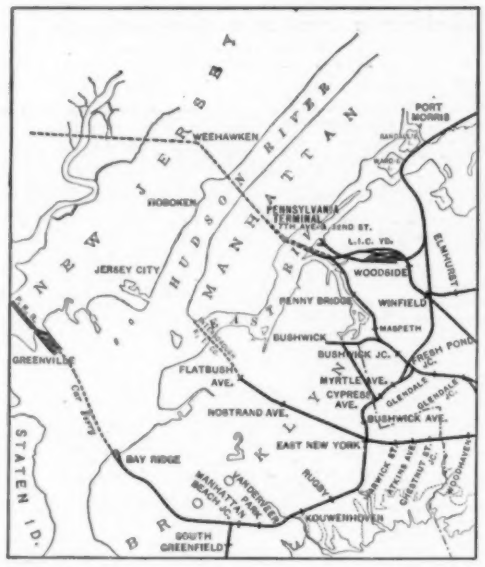
Before going on to New York on the new line running northeast from Harrison, a short trip over to Newark on the proposed electric line running to Park Place Station shows the facilities which the Pennsylvania is providing for rapid transit service between Newark and New York. Electric trains are to run from Park Place Station in Newark to Harrison, and from there over an electrified line to Jersey City. Track connections will be made with the Hudson and Manhattan Railroad, so that the Newark trains will run direct to the Hudson Terminal at Cortlandt and Church Streets in the lower part of New York city. Later it may be found desirable to run some of the Newark electric trains into the New York Station at Thirty-third Street by way of Harrison.

THE PENNSYLVANIA STATION.

The Pennsylvania Station in New York city is most advantageously situated, the main entrance being on Seventh Avenue between Thirty-first and Thirty-third Streets. The tracks are 40 feet below the street surface, and the station is divided into three levels. The Seventh Avenue entrance is for foot passengers only. It leads to the main waiting room through an arcade 225 feet long by 45 feet wide, flanked on both sides by shops and booths. At the farther end of the arcade are the restaurant, lunch rooms and café, and beyond is the general waiting room and concourse.

On the first level below the street is the station proper. Here is the general waiting room, the largest in the world, 277 by 103 feet. Within its walls are located the ticket offices and baggage checking windows, all so arranged that a passenger may proceed from one to the other with a minimum amount of exertion and without retracing his steps. Adjoining the general waiting room on the west are two subsidiary waiting rooms, 58 by 100 feet, for men and women, provided with seats, and opening into retiring rooms.

On the same level with the general waiting room the main baggage room, with 450 feet of frontage, is located. This is for the use of the transfer wagons, and covers the full area occupied by the arcade and restaurants on the plane above. Baggage is delivered and taken away through a special subway. From the baggage room trunks are delivered to the tracks below



MAP OF PENNSYLVANIA RAILROAD SYSTEM IN VICINITY OF NEW YORK.

by motor trucks and elevators. Motor cabs will also be stationed on this level.

Parallel to and connecting with the main waiting room by a wide thoroughfare is the concourse, a covered assembling place over 200 feet wide, extending the entire width of the station and under the adjoining streets. An idea of the width of this concourse is gained by a comparison of it with the lobby of the Jersey City train shed, which is narrower by twenty-five feet. This is the vestibule to the tracks; stairs descend from it to each of the train platforms on the track level. The concourse and adjacent areas are open to the tracks, forming a courtyard 340 feet wide by 210 feet broad, roofed by a lofty train shed of iron and glass. In addition to the entrances to the concourse from the waiting room there are also direct approaches from the streets.

Auxiliary to the main concourse and located between it and the tracks is a sub-concourse, sixty feet wide, which will be used for exit purposes only. This exit concourse is eighteen feet above the tracks, but is connected with the track level by two stairways and one elevator from each platform. From it ample staircases and inclines lead directly to the street.

The northern side of the station extending along Thirty-third Street is assigned to the Long Island Railroad. Into this part of the station trains will run from all points on Long Island by way of the East River tunnels. Ample entrances and exits are provided, so that this traffic can be handled independently.

The third level for the passenger is the train platform, about thirty-six feet below the surface of the street. This level is so gradually reached that the descent is scarcely noticeable.

The stone work of the station, inclosing some eight acres of ground, was completed on July 31st, 1909. To inclose this vast area has necessitated the building of exterior walls aggregating 2,458 feet—nearly half a mile—in length, and has required 490,000 cubic feet of pink granite. In addition, there have been utilized inside the concourse 60,000 cubic feet of stone. A total of 550,000 cubic feet of granite has thus been utilized in the construction and ornamentation of this building. It took 1,140 freight cars to transport these 47,000 tons of stone from Milford, Mass.

In addition to the granite, the construction of this building has called for the use of 27,000 tons of steel. There have also been set in place some 15,000,000 bricks, weighing a total of 48,000 tons. The first stone of the masonry work on the building was laid June 15th, 1908; the entire masonry was thus completed in approximately thirteen months after the work was begun.

Built after the Roman Doric style of architecture, the building covers the entire area bounded by Seventh and Eighth Avenues and Thirty-first and Thirty-third Streets. The depth of the property on both streets is 799 feet 11¼ inches, and the length of the building is 788 feet 9 inches, thus allowing for extra-wide sidewalks on both avenues. The walls extend for 430 feet 6 inches from Thirty-first Street to Thirty-third Street, the Seventh Avenue façade signalizing the main entrance.

In designing the exterior of the building, Messrs. McKim, Mead & White, the architects, were at pains to embody two ideas: To express in so far as was practicable, with the unusual condition of tracks far below the street surface and in spite of the absence of the conventional train shed, the exterior design of a great railway station in a generally accepted form; and also to give to the building the character of a monumental gateway and entrance to a great metropolis.

Apart from those two ideas, the plan of the station was designed to give the greatest number of lines of circulation. The structure is really a monumental bridge over the tracks, with entrances to the streets on the main axes and on all four sides. In this respect this building is unique among the railroad stations of the world, affording the maximum amount of entrance and exit facilities possible.

The Seventh Avenue façade is composed principally of a Roman Doric colonnade, double at the carriage entrances at the street ends and at the main front entrance for pedestrians in the center, each of the columns being 4 feet 6 inches in diameter and 35 feet high. Above the central colonnade is an entabla-

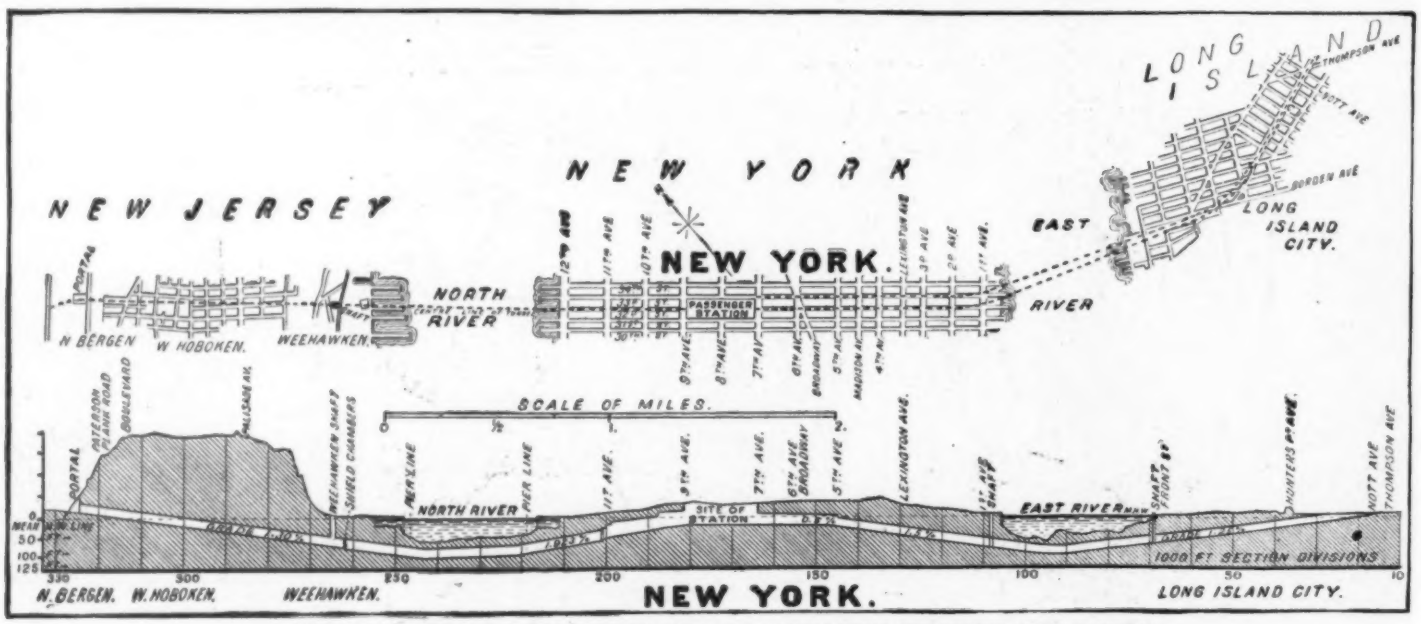


DIAGRAM SHOWING THE LINE OF THE PENNSYLVANIA TUNNELS UNDER THE HUDSON AND EAST RIVERS.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

ture surmounted by a clock with a dial 7 feet in diameter. The center of this clock is on the axial line of Thirty-second Street, and 61 feet above the sidewalk.

This Seventh Avenue façade was conceived especially to express in largest possible fashion a monumental gateway. It may be compared in a greatly magnified manner to the Brandenburg Gate in Berlin, through which passes so much of the traffic of that city.

The main body of the building approximates in height the Bourse of Paris, reaching 76 feet above the street level. With entrances through each of the two corners of the station on Seventh Avenue there are carriage drives, each about 63 feet wide, or the width of a standard New York city street, fronted by double columns and pediments. The frontages on Thirty-first and Thirty-third Streets are similar. The walls of the exterior of the carriage drives are of pilaster treatment for a distance of some 279 feet.

Midway along the sides of the building, signalizing the entrances on Thirty-first and Thirty-third Streets, are series of columns of the same dimensions as those on the Seventh and Eighth Avenue façades, for a distance of 117 feet. Above these colonnades are also sculptured groups supporting large ornamental clocks. For 116 feet beyond there are interrupted colonnades, after which the walls are of pilaster treatment to Eighth Avenue, with the exception of 45-foot colonnades marking entrances to the concourse.

The Eighth Avenue frontage is treated on the plan of pilasters except for 44 feet 6 inches, which is broken by columns into intervals of three spaces to mark another spacious entrance to the main floor of the concourse.

One of the distinctive features of this buiding is the waiting room, which extends from Thirty-first to Thirty-third Streets, its walls parallel to Seventh and Eighth Avenues, for a distance of 314 feet 4 inches. The height of this room is 150 feet and its width 108 feet 8 inches. The walls of the waiting room above the main body of the building contain on each side three semi-circular windows of a radius of 33 feet

Bird's eye view, showing the vast area, 2,050 feet by 500 feet, which was excavated to a depth of 50 feet, necessitating the removal of 2,000,000 cubic yards of material.

ACRES OF VALUABLE LAND IN THE HEART OF NEW YORK LAID WASTE FOR THE NEW PENNSYLVANIA RAILROAD STATION.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

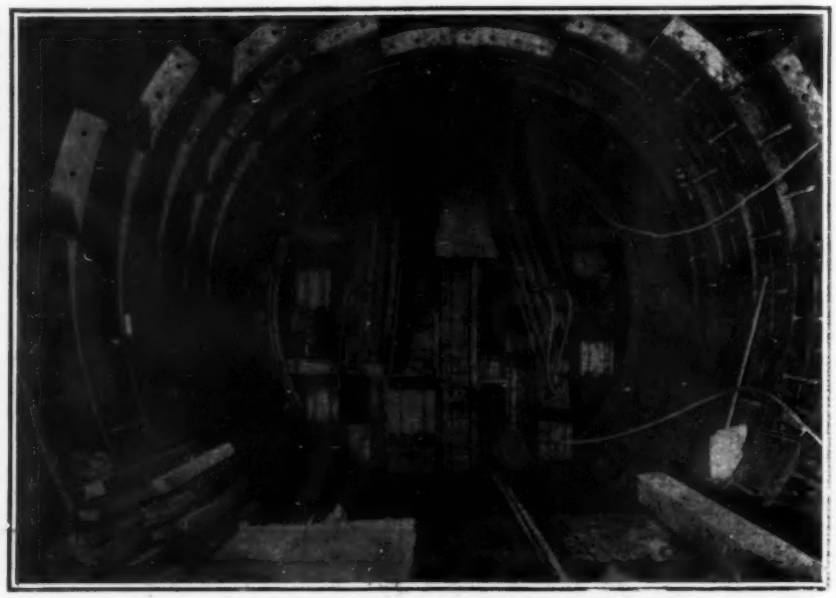
4 inches and 66 feet 8 inches wide at the base. There is also a window of like size at each end of the waiting room.

The dignified design of the interior of the general waiting room, while fully adapted to modern ideas, was suggested by the great halls and basilicas of Rome, such as the baths of Caracalla, Titus and Diocletian, and the basilica of Constantine, which are perhaps the greatest examples in history of large roofed-in areas treated in a monumental manner.

neers who had charge of the construction of the New York Tunnel Extension:

Area (Tenth Avenue to normal tunnel section east of Seventh Avenue)	28 acres
Length of trackage	16 miles
Number of standing tracks at station	21
Length of platforms adjacent to passenger trains	21,500 feet
Total excavation required	3,000,000 cu. yds
Length of retaining walls	7,800 feet
Number of lineal feet of streets and avenues carried on bridging	4,400 or an area of about 8 acres
Dimensions of passenger station building: 784 feet long, 430 feet wide, average height above street 69 feet, maximum height above street 153 feet.	

FRONT VIEW OF THE SHIELD USED IN THE PENNSYLVANIA TUNNEL.



TAIL OF A PENNSYLVANIA SHIELD, SHOWING A PORTION OF TUNNEL LINING TEMPORARILY ERECTED.

This view shows the point where C tunnel crosses over B near the Long Island portal.

VIEW LOOKING WEST AT PENNSYLVANIA RAILROAD TUNNELS AS THEY NEAR THE SURFACE IN LONG ISLAND CITY.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

While the façades of the station were intended to suggest the imposing character of these ancient Roman temples and baths, the impression intended to be made upon the layman approaching the station, in full view of the exterior of the general waiting room with its huge semi-circular windows, is that of one of the leading railway stations of the world.

In addition to this description of the architectural features of the station, and of its interior arrangement, these statistics have been supplied by the engi-

Number of passenger platforms	11
Highest point of tracks—below sea level (M. H. W.)	9 feet
Number of baggage and express lifts	25
Length of baggage express trucking and pipe subways	5,200 feet
Weight of street bridging steel	23,500 tons
Weight of station building steel	27,000 tons
Weight of steel in service building	2,437 tons
Dimensions of main waiting room: 277 feet long, 103 feet wide, 150 feet high.	
Dimensions of concourse: 340 feet long, 210 feet wide.	
Concrete required for retaining walls, foundations, street bridging and sub-structures	160,000 cu. yds.
Loading per square foot on avenue bridging	1¾ tons

Maximum loading per square foot on bridging east of Seventh Avenue..	5 tons
Number of columns supporting station building	650
Greatest weight on one column.....	1,658 tons
Number of buildings removed on terminal area—about	500
Dimensions of service power plant in Thirty-first Street	160 feet x 100 feet
Boiler capacity of service power plant (ultimate)	5,000 H. P.
Number of electric lights, in terms of 16-candle-power lamps, and inclosed arc lamps in passenger station building: Arc, 532; incandescent, 21,951; about.....	30,000
Maximum capacity of all tunnels in trains per hour.....	144
Storage capacity of station yard tracks	386 cars
Proposed initial daily service of P. R. R. trains.....	400
Proposed initial daily service of L. I. R. R. trains.....	600
	1,000 trains
Length of river (tube) tunnels (single track miles).....	6.8 miles
Length of land tunnels (single track miles)	6.8 miles
Length of run, Bergen Portal to Long Island Portal.....	5.3 miles
Total length of track in tunnels, exclusive of yard tracks in station..	16.5 miles
Length of run, Harrison to Terminal Station	8.6 miles
Length of run, Jamaica to Terminal Station	11.85 miles

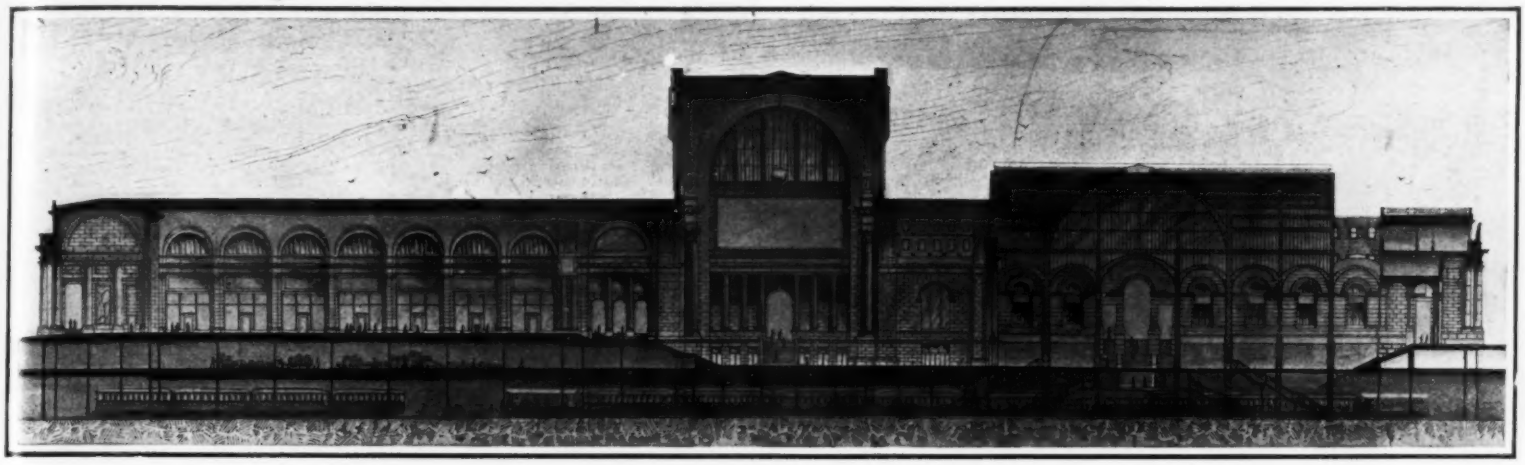
When the two tracks emerge from the tubes under the Hudson and reach the entrance to the station yards at Tenth Avenue they begin to spread out. From Ninth Avenue, and extending into the station, the number grows from two to twenty-one. There is a reduction in the number of tracks leading out of the station yard to the east, to a total of four for the main line, passing under the city, and thence under the East River to the Sunnyside Yard on Long Island.

From the station twin tunnels, giving four tracks in all, traverse a section of New York city, second in importance only to the financial district, and one that includes the larger hotels, retail shops and theaters, and many residences. The Manhattan Crosstown Tunnels end at the river shaft, is situated in the block between Thirty-third and Thirty-fourth Streets east of First Avenue. From this point the under-river tubes, four in number, extend under the East River to Long Island City and Sunnyside Yard—the terminus of the tunnel extension.

Sunnyside Yard is to the New York improvement what the West Philadelphia passenger yard is to the Philadelphia terminal, or the Jersey City yard to the Jersey City station. The new yard has many interesting features, such as the provision for running all trains around a loop, pulling them into the coach-cleaning yard at one end and departing from the other end, thus turning the entire train and avoiding the necessity for switching baggage cars and sleeping cars to opposite ends of the trains and the turning of combination cars separately. The arrangement of tracks on different levels makes provision for cross-over movements without grade crossings and eliminates interference with high-speed traffic.

Sunnyside Yard is 5,500 feet long and 1,550 feet wide, embracing some 153 acres of land. It contains 73 miles of track which have a capacity of 1,550 cars. There is additional space for extending the trackage of the yard to provide for more car standing room whenever it is required.

From Sunnyside Yard there are tracks leading to



SECTIONAL VIEW OF THE STATION ON A LINE RUNNING EAST AND WEST.

On the left is seen the brick-covered concrete top of one completed tunnel; dotted lines show position of completed portions of the others, to be joined to those shown in course of construction in other view.

VIEW LOOKING EAST FROM THE SAME POINT; SUNNYSIDE YARD IN THE DISTANCE.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

the New York Connecting Railroad, the lines of which will form a junction with the New York, New Haven & Hartford Railroad at Port Morris, New York. The Connecting Railroad will cross the East River by the "Hell Gate" Bridge over Ward's and Randall's Islands.

In connection with its improvement in and around New York city, the Pennsylvania Railroad Company has constructed at Greenville, N. J., an extensive freight transfer yard. It is also the most completely equipped yard for the rapid and economic handling of freight. From Greenville the cars are transported by floats and delivered to the great piers of the city. Freight destined to Brooklyn or to other points on Long Island is floated across the bay from Greenville to Bay Ridge, on the opposite shore of Long Island. Freight for New England and eastern points is floated up the East River to the New York, New Haven & Hartford Railroad's Port Morris station. Later, when the New York Connecting Railroad is constructed, freight will be floated to Bay Ridge and run over Long Island tracks to the Connecting Railroad, and thence to the mainland, where connection is made with the New York, New Haven & Hartford Railroad system for Boston and New England points.

CORNER OF LOGGIA IN THE NEW YORK TERMINAL STATION.

CONCOURSE OF THE NEW YORK TERMINAL STATION.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

One of the most important features of the Pennsylvania Railroad's New York Tunnel Extension is its relation to the Long Island Railroad—a subsidiary line of the Pennsylvania, and the only other road that will operate trains into the New York passenger station.

It is estimated that forty minutes will be saved between Long Island points and New York city by the operation of trains through the East River tunnels into the Pennsylvania station at Thirty-third Street and Seventh Avenue.

In addition to the many millions the Pennsylvania Railroad has spent and is spending for the four tunnels under the East River, and the vast station and terminal in Manhattan by which all Long Island will benefit, the Long Island Railroad is increasing its own facilities in all directions to take care of the present large traffic and the larger traffic which will come upon the completion of the tunnels. To accomplish this will necessitate an expenditure on the part of the Long Island Railroad of more than thirty million dollars.

The population included within a circle of 19 miles radius, with City Hall, Manhattan, as the center, in 1890 was 3,326,998; in 1900 it was 4,612,153, and five years later it was 5,404,638, an increase in ten years of 38 per cent. In 1913 it is estimated that the population of this territory will approximate six million people, and in 1920 eight million people.

Railroads on the western bank of the Hudson River opposite New York city carried in 1886 nearly 59,000,000 people. In 1890 they carried over 72,000,000, in 1896 more than 94,000,000, and in 1906 about 140,000,000 people.

These startling figures were considered when the Pennsylvania Railroad was contemplating entering New York city. It was evident that one of the greatest transportation problems in history was rapidly evolving, and it was only by quick action that the railroads could prepare facilities to cope with it.

With the traffic in and out of New York city growing as it has grown in the past twenty years, the situation confronting the management of the railroad was whether the quantity of this traffic was such as to warrant any other method of transportation than ferries for crossing the North and East Rivers, and

ARCADE ENTRANCE TO LOGGIA.

WAITING ROOM—DETAIL TO 33RD STREET SIDE.

WAITING ROOM IN THE NEW YORK TERMINAL STATION.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

whether any progressive railroad with lines terminating in New Jersey should be content to utilize practically the same facilities for entering and leaving New York city that had existed for thirty years. The action taken by the Pennsylvania Railroad shows the way in which this situation was met.

HOW THE TUNNELS WERE BUILT.

The construction of these tunnels for a trunk line railroad through rock and mud, under two rivers, and undermining New York city from river to river, was a bold engineering feat. The tunnels were bored for the most part by means of huge shields which burrowed their way through silt and sand seventy feet below the surface of the river.

The tunnels or tubes themselves consist of a series of iron rings, and the installation of every ring meant an advance of two and a half feet. Eleven plates and a key piece at the top complete the circumference. An entire ring weighs about fifteen tons. The cast-iron plates or sections of the ring have flanges at right angles to the surface, and it is through these that the successive rings are held together with bolts. Hydraulic rams, placed against the flanges every few inches around the tube, were used to push the shield forward.

The shield used in boring the Pennsylvania tunnels weighed 194 tons. It had nine doors in it, and through these came the rock or sand, or silt, or whatever the material the tube penetrated. Thirty men worked in a gang, and there were three shifts in the day of twenty-four hours. The record progress was five rings, or twelve and a half feet, in eight hours.

Men of all nationalities built the Pennsylvania tunnels, negroes doing a large part of the work. Laziness was something the contractors never had to contend with; they say there must be something about the compressed air which generates energy and enthusiasm, for the "muckers"—commonly known as "sand hogs"—vied with one another to make the record number of rings.

Perhaps there has never been an engineering project in which theory and practice were so nearly in agreement. The engineers calculated the difficulties closely, and a really remarkable system of reports was in effect from the first day work was started. Every morning they knew the progress made in the tunnels the day before, to the very inch, and the amount of rock and soil excavated, to the cubic foot. The Pennsylvania Railroad officers and the engineers hold this perfect system and the thoroughness of each day's work chiefly responsible for the promptness of the meeting of the tubes.

Engineers say, too, that no project was ever carried out where the emphasis was so entirely upon the results, rather than upon the money it cost to attain them.

In the construction of the tunnels, nothing was left undone by the railroad company to protect the lives and health of the workmen engaged on the work. No engineering problem connected with the entire New York Tunnel Extension received more attention than the many precautions to protect the hundreds of men who, day and night, week days and Sundays and holidays, bored the under-river tunnels. Down under many fathoms of mud and rock the steel tubes which are to land passengers from the East and West into the heart of New York city were pushed steadily forward with no more waste of time than it [illegible] change "shifts."

Under-water work has a fearsome sound—[illegible] who have never seen it going on. Talk to [illegible] have been engaged in it for years and you get [illegible] idea. There are plenty who can speak with [illegible] ity, for the world was searched for men of ex[illegible] to build the Pennsylvania tunnels. On the cr[illegible] shafts sixty Austrians, who got their training [illegible] Simplon tunnel, were employed. There were e[illegible] and foremen here who had tunneled in Egyp[illegible] Africa, England, and America, and who now ar[illegible] less looking for other subterranean regions to c[illegible]

All the excitement was taken out of one [illegible] visit back of the tunnel shield by finding [illegible] Brown, the oldest foreman on the contractor[illegible] seated on a pile of river-bed silt, gravely squ[illegible] mud balls for the purpose of finding how much [illegible] the sand carried at that spot. That nothing bu[illegible] air pressure kept the whole of the river from de[illegible] ing on his head, worried him not the least.

But the dangers of the work? Dangers there a[illegible] a certain risk of injury, but not enough to wo[illegible] man in good health who observed the rules that [illegible] him in the face from every wall.

To make it as safe under the bed of a river a[illegible] on the land's surface was the aim of the Pennsyl[illegible] tunnel builders. The old Hudson River tunnel, [illegible] crosses the Hudson at Morton Street, was aban[illegible] at one time because so many lives were lost. The [illegible] difficulty was to keep the river from coming int[illegible] tube and drowning the workmen. The air under [illegible] heavy pressure required to keep the water from [illegible]

THE AREA OF THE NEW YORK TERMINAL STATION OF THE PENNSYLVANIA IS 28 ACRES; THE LENGTH OF TRACKAGE IS 16 MILES; THERE ARE [illegible] THE STAT[illegible]

THE PENNSYLVANIA R[illegible] IN NEW[illegible]

sometimes blew off the tunnel altogether, and water poured in in such volume that there e or no time for escape.

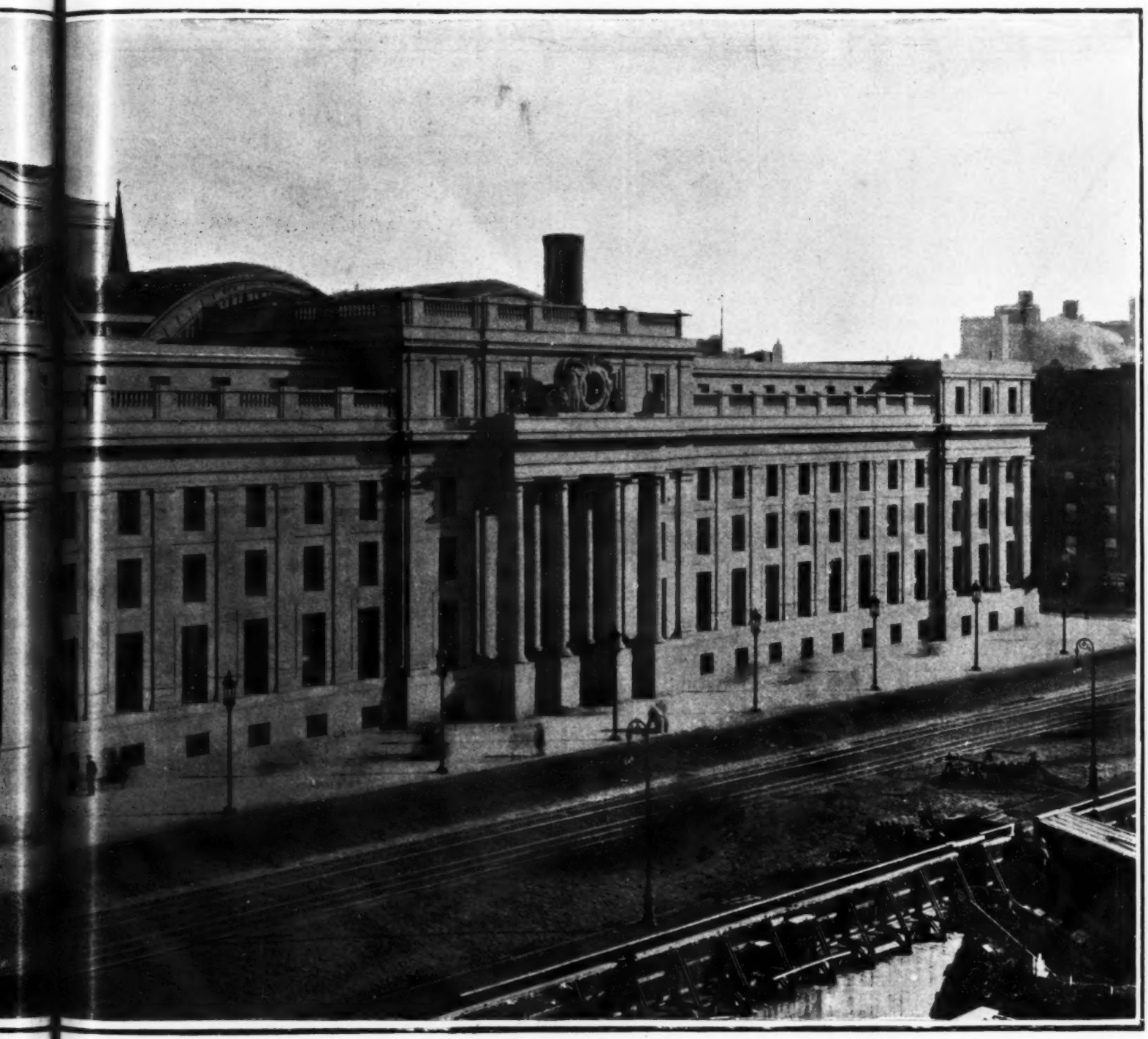
Pennsylvania Railroad tunnels the life of the " was at least as safe as that of the surface Except at times, when it was necessary to ew men out back of the shield, the workers tected by the rings of iron which form the in front was the more massive shield.

ost important of the rules enforced while the nia tunnels were being built was one requir- nen to go slowly through the air locks. The to take a minute for about two pounds of In other words, in coming out of a pressure unds a man should spend not less than 15 in the lock. Finding that this rule was ig-

THE DREADNOUGHT CONTROVERSY.

THE paper on the battleship of the future, read by Admiral Bacon at the Naval Architects last week, revived in a mild form the controversy which raged round the design of the Dreadnought some time ago. Sir Gerard Noel accurately described the paper as a defense of the "Dreadnought," and we may treat Admiral Bacon's rejoinder that no defense is necessary, much as a judge would a counsel who submitted he has no case to answer. Now, as every schoolboy knows, the features which distinguished the "Dreadnought" from all previous battleships were principally the increase of dimensions and speed and the absence of a secondary armament. In the words of Admiral Bacon: "The directness which characterized the Admiralty administration of that period swept aside all powers, and it would be folly to build on a smaller scale than our neighbors.

The real point in this discussion of size is often missed. It is the only profitable point to consider in this part of the controversy, and it is this: Displacement will grow as time goes on, but it ought to follow a natural law, and not be artificially hastened. It would be as reasonable to argue that since we must all "shuffle off this mortal coil" we may as well commit harri-kari at once, as rapidly to increase the size of our ships because we foresee that some day the displacement will be double what it is at present. This country, above all others, requires a numerous fleet, and as our financial resources are not infinite, increase in cost of individual ships must eventually result in a restriction of the number, and it would appear fairly



THE STATION; THE LENGTH OF THE PLATFORMS ADJACENT TO PASSENGER TRAINS IS 21,500 FEET; THERE ARE 11 PASSENGER PLATFORMS.

IN NEW YORK.

enry Japp, managing engineer of the contrac- built the East River tubes, devised a valve abled the lock tender to regulate the change re with mechanical exactness.

a man was permitted to work in the under- nels, he was put through a severe examina- eart and lung troubles and general condition. ed the medical inspection he was sent "down " for an hour or two, and then re-examined. ond examination was satisfactorily passed he on a short shift for a week, and then if he o ill effects was given a steady job.

was the mainstay of the tunnel worker, and it e had at all times and at all places. Every as equipped with a coffee machine, and the ge was on tap at all hours of the day and thout charge.

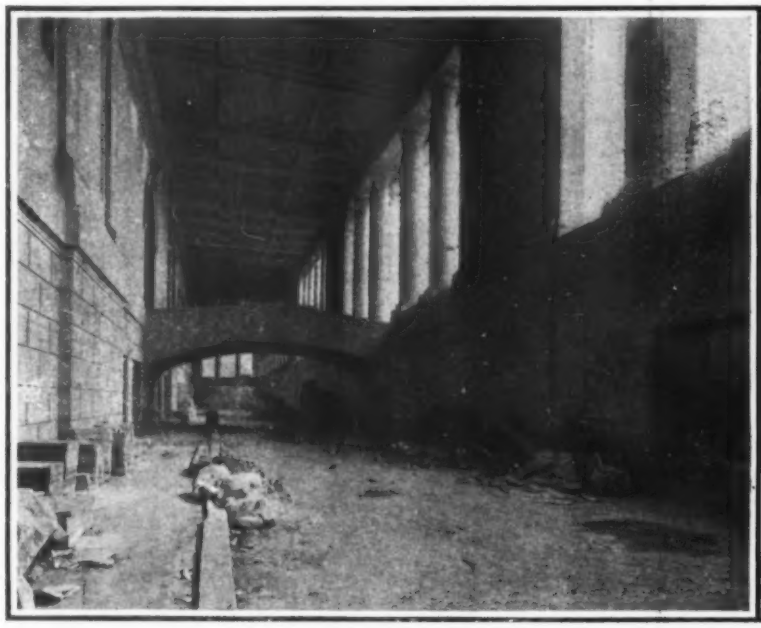
compromise and designed a ship with no guns of any sort except the 12-inch and the 12-pounder." The increase of dimensions, coupled with the introduction of turbines, made possible the increase of speed, so that it is not necessary to refer to dimensions and speed separately. The wisdom or otherwise of the increase of size affords little scope for profitable discussion, since in the history of naval construction there are two outstanding indisputable features—that size always tends to increase, and that from any one stage in the development no return is possible to smaller dimensions. Once the step is made it is irrevocable, and even those who regret the increased cost of the "Dreadnought" type will agree that unless some discovery of a revolutionary character is made a return to smaller battleships is out of the question. Vessels of corresponding or larger size are being built by foreign

obvious that, subject to the individual vessels comparing favorably with contemporaneous foreign vessels, they should be as small as possible. The point is, we repeat, not whether it is possible to get greater fighting power on a large displacement. If that were the only thing to be considered the resources of engineering would allow us to go up to vessels of 50,000 or 60,000 tons immediately. What we have to consider is whether the development of foreign vessels calls for increase of size, and, if so, what is the minimum which will give us the necessary advantage. The balance of evidence is against the contention that the increase in the "Dreadnought" was at the time justified by the action of foreign powers, but as we cannot now go back it ought to be a cardinal consideration that similar steps are not taken in future. Unfortunately, the "Dreadnought," instead of, as was hoped,

stifling competition, has put additional life into it, and we have already reached in this country a displacement of 26,500 tons, while in America battleships of 32,000 tons are in contemplation. The situation is analogous to the wars of rates which occasionally disturb the commercial world, and which, if they do not ruin one or more of the competitors, are only ended by an agreement to limit prices. It is too much to expect, in view of the non-success of efforts in this direction in the past, that any agreement is possible toward limitation of armaments, either in respect to size of vessel or numbers.

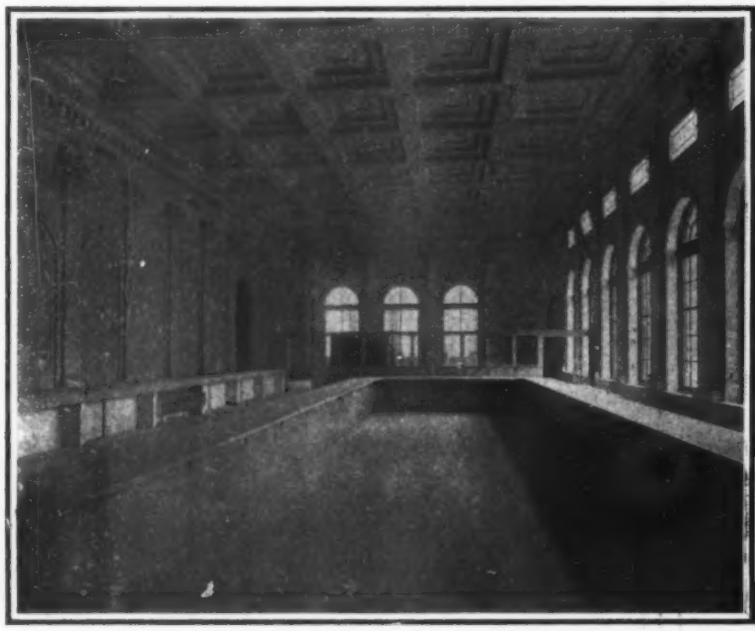
We turn to the other feature of the "Dreadnought" design, and here, as Sir William White remarked, it is astonishing that every considerable naval power except ourselves remains convinced as to the value of a powerful secondary armament. A distinction must be drawn between the smaller guns, such as the 12-pounder or 4-inch, which are only expected to be of service against torpedo attack, and the secondary armament proper, which, strictly speaking, should embrace any guns of caliber between the main armament and the 6-inch weapon. Some people, indeed, consider the 6-inch as an ideal anti-torpedo gun, though it would be almost as accurate to describe a sledge hammer as the ideal instrument for cracking nuts. Torpedo attacks are not made in the open when the vessel attacked has ample time to train her guns on the torpedo boat or destroyer, unless it is at the end of an engagement against a practically disabled ship. They are made under cover of darkness or some other favorable screen, and to be effective the attack must be sudden and unexpected. To meet such an attack under these conditions volume and rapidity of fire rather than strength of individual hits is essential, for it is fairly certain that much of the shooting will, even with the best-trained gunners, be wide of the mark under such adverse conditions. The number of guns mounted for this purpose is, therefore, more important than their size, provided they be of such caliber that a single shot can disable the adversary. A single 12-pounder shell will wreck a destroyer's engine-room, and a 4-inch shell accurately placed between wind and water would in all probability sink her. As the effective range of the torpedo is increased the size of the anti-torpedo gun must go up also, so as to be equally effective against destroyers at the longer ranges, but it is easy to see that the smaller the gun which is suitable for the work the greater will be the number of positions which can be found for mounting it in a vessel of given dimensions. These are considerations more or less outside the range of controversy, but the efficacy and the desirability of mounting guns intermediate in size between the anti-torpedo and the main armament is a question on which opinion is very sharply divided in this country, though, as we have stated, other navies seem to entertain no doubts at all on the subject. The reasons which Admiral Bacon gives against the secondary armament are two in number. The first is that these guns tend to reduce the accuracy of fire of the heavier guns, and the second that the weight, and therefore the extra tonnage, that the installation demands could be better devoted to other purposes. He also stated that they could not be mounted without restricting the fire of the heavy guns, but this argument was demolished by Sir William, who pointed out that in some American ships eight large guns had been employed with a powerful secondary armament free from the defect which Admiral Bacon said must accompany it. As to the question of fire control it does not require an expert to appreciate Admiral Bacon's point as to the difficulty of correcting the fire of different calibers of guns with varying rapidity of fire and varying external ballistics. The matter is no doubt of importance with respect to gunnery returns and target practice, but the point is what exactly will be the extent of their disability under real conditions. The experiments carried out against the old battleship "Hero" are reported to have shown that fire control stations are not likely to survive after the first few minutes of an engagement, and if this is the case firing would become independent, and each gun's crew would have to rely upon its own judgment. Under such conditions some accuracy of fire due to the absence of fire control would be lost, but it does not appear likely that any one gun would interfere with another's accuracy.

No one can read the absorbing narrative by Captain Semenoff of the battle of Tsu-Shima without being struck by the undoubted havoc which the 6-inch guns of the Japanese vessels caused, and the fact that since the war the Japanese themselves have laid down battleships with powerful secondary armaments shows that they appreciated the part which these guns played. Admiral Bacon, in his reply, endeavored to discount the lesson of Tsu-Shima by the arguments that this battle was fought with old type ships, and that gunnery had enormously improved since that date. From a less powerful advocate than Admiral Bacon these arguments would appear entirely inconclusive. We must assume equality of type of ship on either side, and what was true of battleships of the "Royal Sovereign" and "Majestic" ero should be true, *mutatis mutandis*, of vessels of the "Dreadnought" era. The argument based on improvement of gunnery also has little weight unless we assume that the fire control remains undamaged, and so gives the single-caliber ship the advantage. Another point, which escaped notice at the meeting, is the fact that larger guns have a much shorter life than the smaller. The longer a decisive action is deferred in a naval war the more important relatively becomes the secondary armament, as the big guns become badly worn and accuracy of shooting falls off more rapidly than in the

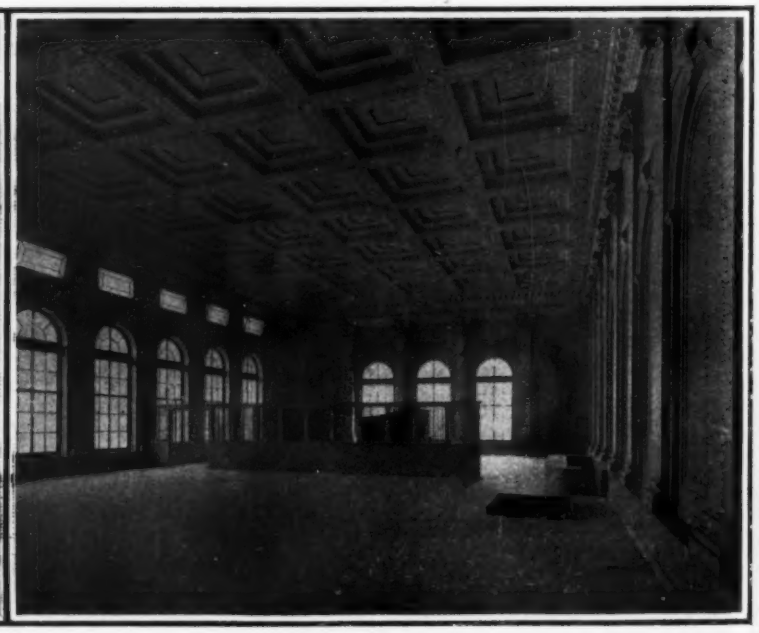


DRIVEWAY OF THE TERMINAL STATION.

ARCADE OF THE STATION.



LUNCHEON ROOM.



THE RESTAURANT ROOM.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

case of the smaller guns. This point is brought out in Captain Semenoff's book, and no doubt in a measure accounts for the large proportionate effect produced by the Japanese 6-inch guns. The question of secondary armament is, as Sir William said, a vital one, and in view of the decided course taken by other navies should be carefully reconsidered.—The Engineer.

SIR J. J. THOMSON ON GOLF BALLS.

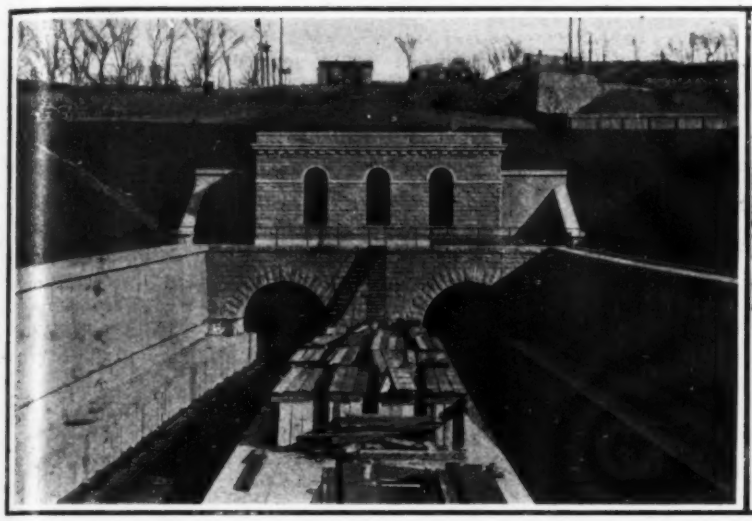
In a recent lecture at the Royal Institution Sir J. J. Thomson discussed the "Dynamics of a Golf Ball," in which he said, that various explanations of the behavior of golf balls had been put forward, and if all of these were sound his lecture should be exceptionally interesting, for he would have to enunciate a new theory of dynamics. It sometimes seemed that the better the golfer the worse his dynamics; if the converse were the case, every confidence might be felt in the results he had to bring forward. If the ball was in the exceptional position of having no spin it moved forward without deviating to the right or the left. If it had spin, its course was more erratic; yet its movements were the result of a commonplace and prosaic law, which was its only secret so far as the broad effects were concerned—he would not say the minutiæ—that it always tried to follow its own nose. Practically the complete explanation was given by Newton, who pointed out that the pressure was greatest on that side of a tennis ball at which the forward and the rotary motions conspired together; hence the reaction of the air was greater on that side, and the ball was pushed in the direction in which it followed its own nose.

To demonstrate this difference of pressure the lecturer showed an experiment, which consisted in placing two tubes, connected to a manometer, at opposite sides of a cylinder rotating in the blast from a blower. By employing golf-balls in place of the cylinder he was also able to show the effects of smooth and rough surfaces, the difference of pressure with the latter being distinctly the larger. A ball with under-spin tended to rise, according to the law, and if its speed of travel and speed of rotation were both considerable it might pursue a course doubling on itself in a loop, though such a phenomenon might not be commonly observed on a golf-links. The production of a path with a kink in it would be facilitated by using a light ball, and with the aid of a gas-balloon, in which the weight was largely reduced, the effects of spin in producing paths of this kind could be readily exhibited.

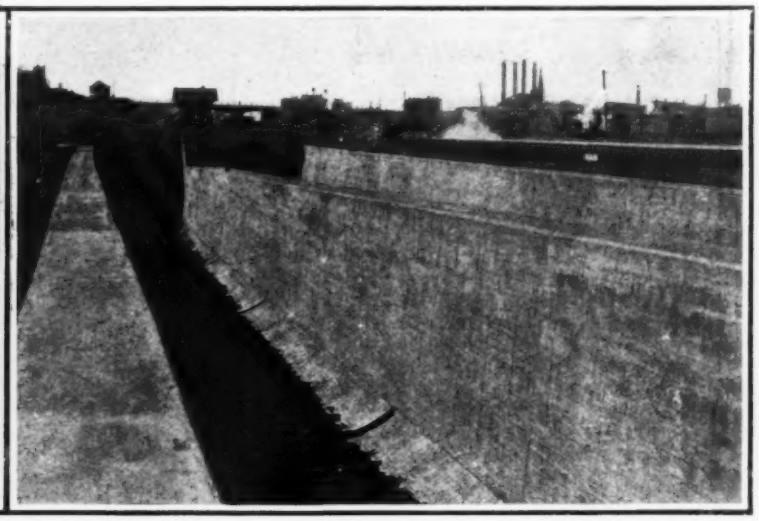
After explaining why the effects of slicing and pulling manifested themselves most strongly toward the end of the flight, as was a matter of common experience, the lecturer applied his laws to the question: How a player should proceed in order to get a long carry in a cross wind? If the wind were from left to right, then the point of pressure would be behind the sliced ball, and slicing would help its flight. On the other hand, the pressure would be in the front of a pulled ball, which, in consequence, would be retarded. Hence theory indicated that to get a long carry in a cross wind from left to right the ball should be driven into the wind, but slightly sliced. His own control over his club was not sufficiently certain to enable him to test this rule; but some of his friends had found it to be sound. Finally, using what he described as an electric golf-links, he showed the analogy between the behavior of the cathode rays in a vacuum tube and the flight of a golf-ball, the spin round any axis being imparted to the electrified particles by means of a magnet. By way of moral he pointed out that much science was connected with golf, cricket, and other games, and he thought it was a pity that the enthusiasm of English boys for games merely as games was not utilized in order to rouse in them an interest in scientific matters.—English Mechanic and World of Science.

SOME CURIOUS PHASES OF CHINESE JOURNALISM.

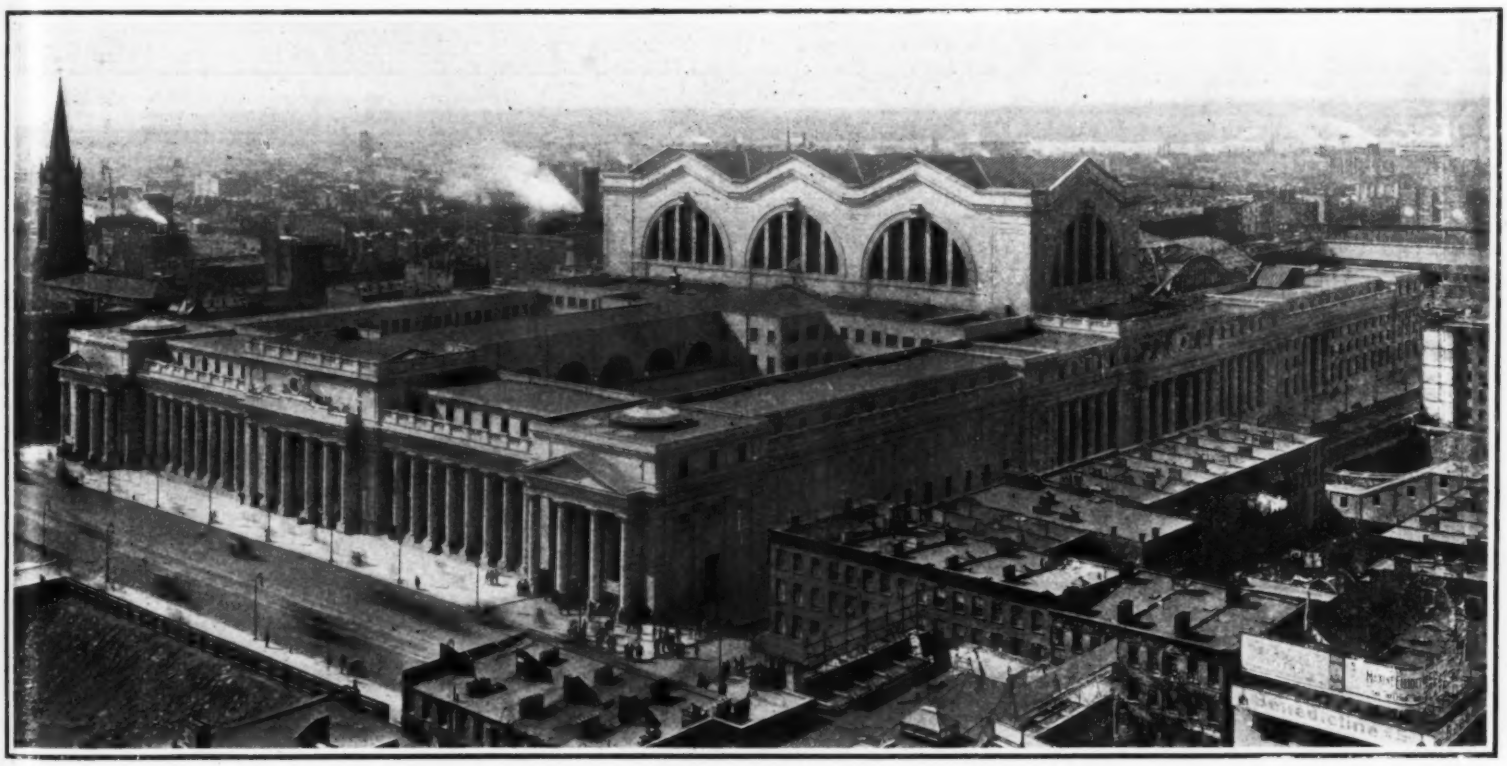
THE Celestial Empire, which is the real cradle of our journalism, and whose oldest newspaper, the Peking Gazette, celebrated its one thousandth anniversary a short time ago, was opened only quite recently to modern journalism. In a late number of the Revue the mandarin Ly-Chao-Pe gossips about the many curious results of the sudden acquaintance of the wearers of the cue with the modes of the present periodical press. It must not be supposed that the Chinese regard the newspaper with faltering attention, rather they show the liveliest interest for all political events and news. One needs only to visit one of the numerous little tea-houses to discover the insatiable desire for gossip that resides in the Sons of the Middle Kingdom. The women, too, share this curiosity with unmistakable insistence, and the laundries everywhere in the Empire, precisely as in the West, are a veritable living newspaper. The newspapers which have been developed since the year 1900 and are issued for the great bulk of the population are published in a most various manner. Some of them make cursory mention of almost everything, so to speak; others devote themselves especially to trade, agriculture, science or religion. A satirical press is also in very keen vogue, swarms with merry caricatures that illumine the caustic criticism with which it describes the conduct of the government, and with merciless candor pictures the daily life of the individual official, prods



ENTRANCE TO NORTH RIVER TUNNELS, BERGEN HILL, N. J.



SUNNYSIDE YARD ENTRANCE TO TUNNELS LEADING UNDER EAST RIVER.



A GENERAL VIEW OF THE PENNSYLVANIA RAILROAD TERMINAL STATION IN NEW YORK CITY.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

with a tantalizing finger all kinds of applicants and candidates who are seeking to pass examination, ridicules the primitive modes of traffic or any other antiquated device.

As is well known, there are seven different styles in Chinese literature: the antique style, the literary style, the flowery or elegant style, the ordinary style, the semi-literary, semi-ordinary style, the familiar style, and the epistolary style.

Naturally the newspapers are written in the ordinary style and make use of the new alphabetic characters which have been substituted by the government for the old and cumbersome characters and have been learned with perfect ease by the poor classes. But it does not suffice that a great list of newspapers be published; the reader must understand them, too, and in this respect a most embarrassing gap soon showed itself. For this reason societies have been formed which provide free popular lectures in towns and villages, which have the sole purpose of explaining the contents of the newspapers.

The common man in China has really not the faintest idea of what is meant by the "preliminary parliament" which the government has installed. And whether popular education is benefited much by such lectures is questionable, for in them one of the things, for instance, that recur most frequently is the explanation why the members of European parliaments attack one another with their fists and lapse so often into similar misconduct.

In the meantime the government is constantly emitting new laws which regard the press. It is especially anxious about the use made of old newspapers. As all the characters of the native script and everything printed are consecrated to the saints of antiquity, any use made of old newspapers for profane purposes would be a profound sin that would surely attract relentless misfortune. It is the popular belief, indeed, that anyone who desecrates anything printed is sooner or later stricken with blindness. Therefore to satisfy the daily need of various common wrappers and remnants a cheap, thick paper of straw is made everywhere. The government explicitly forbids, among other things, the use of newspaper to fortify the soles of sandals and shoes. The intense aversion to degrading anything that is printed is best explained by the fact that a certain class of Fo-priests roam through towns, villages and streets to gather with devout care every visible scrap of newspaper, so that it may not be soiled by anything obnoxious. All such paper is then taken before the images of the old saints and with ceremony is burned in their honor.

THE SYSTEM OF THE UNIVERSE.

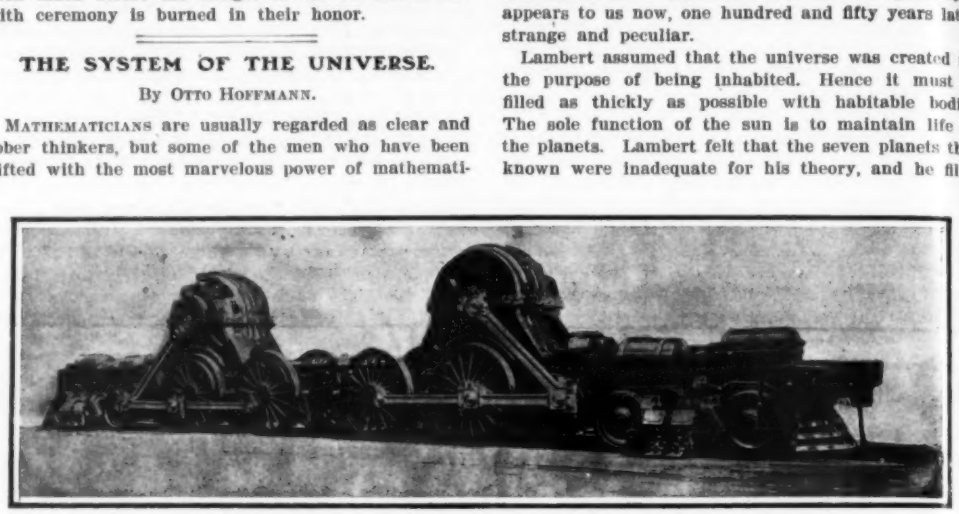
By OTTO HOFFMANN.

MATHEMATICIANS are usually regarded as clear and sober thinkers, but some of the men who have been gifted with the most marvelous power of mathematical analysis have not been free from the defects and vagaries of common mortals. Newton was extremely irritable, Laplace was inordinately vain, Monge, the inventor of descriptive geometry, was very forgetful and absent-minded. These men, however, were not fanciful dreamers, and few such are found among great mathematicians. One of these few was Johann Heinrich Lambert, the first man who endeavored to construct a system of the universe. In Lambert's time, a beginning of the science of celestial mechanics had been made. One of his contemporaries was Laplace, the author of that fundamental work, the "Mécanique céleste"; another was Lagrange, and the fame of these two great men subsequently obscured that of Lambert, who was the son of a tailor of Muhlhausen in Alsace. Lambert's "Cosmological Letters on the System of the Universe," once greatly admired, are now almost completely forgotten, and this is not surprising, notwithstanding the grand conceptions which formed the basis of the work. The world has moved since Lambert's time and his philosophy appears to us now, one hundred and fifty years later, strange and peculiar.

Lambert assumed that the universe was created for the purpose of being inhabited. Hence it must be filled as thickly as possible with habitable bodies. The sole function of the sun is to maintain life on the planets. Lambert felt that the seven planets then known were inadequate for his theory, and he filled space with comets, asserting that there were 3,600 comets within the orbit of Saturn. (As a matter of fact, there are several millions.) All of these comets, notwithstanding the great eccentricity of their orbits, which carry them from the intensely hot vicinity of the sun to the cold depths of space, are, according to Lambert's theory, the seat of manifold and intelligent life. Lambert's exuberant fancy was not confined to the solar system. As the planets with their satellites form a system of the first order, the sun with its planets and comets a system of the second order, Lambert assumed that systems of a third, fourth, and fifth order existed. A system of the third order would be formed by our sun and a number of similar suns revolving round a central sun of vast dimensions. A system of the fourth order would be formed by a similar combination of systems of the third order. Lambert assumed the Milky Way to be such a system of the fourth order, but other Milky Ways may exist, the nebulæ for example, which may be combined into a system of the fifth order. And so on *ad infinitum*. Here Lambert entered upon ground which neither Laplace nor Lagrange had ventured to tread. Both of these great men remained on the firm basis of mathematical analysis, while Lambert's hypotheses are the product of an unrestrained imagination. The recently deceased American astronomer Newcomb criticises poor Lambert rather too severely in asserting that Lambert's theories are entirely destitute of scientific foundation. For centuries, indeed, it appeared as if all the labor and acumen employed in the construction of systems of the universe were necessarily wasted. Within the last few years, however, some progress has been made in this field.

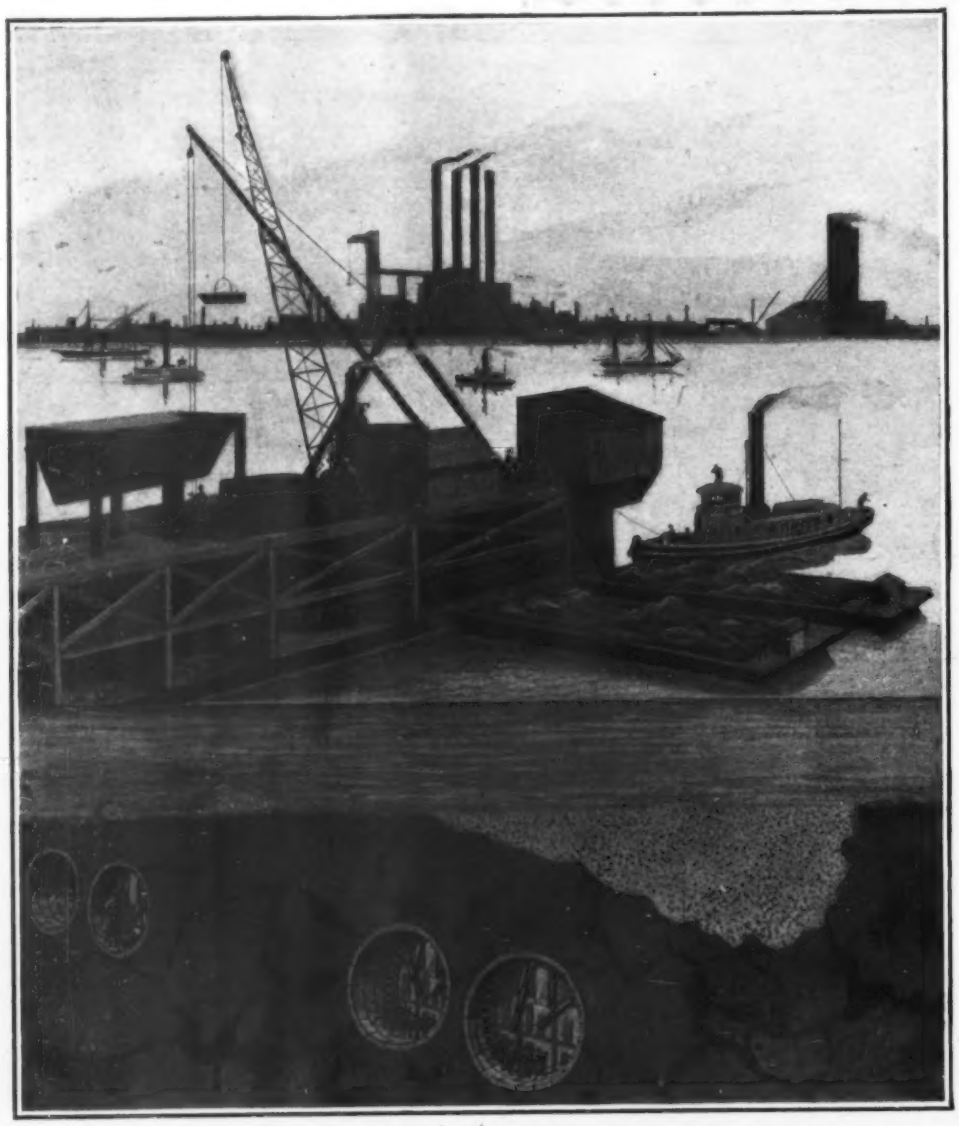
We now know that there is no central sun, in Lambert's sense. It is very probable, indeed, that an accumulation of matter, sufficiently vast to represent the central sun of a star cluster, is physically impossible. Assuming that the proportions of our solar system are repeated in such a cluster, the central sun would be large enough to fill the orbit of the earth and, if its density were equal to that of our sun, the pressure at the center of this huge ball would be sufficient to crush the atoms themselves. Sirius, which Kant regarded as such a central sun, and Alcyone, which Maedler assumed to represent a center of attraction, are masses of the order of magnitude of our own sun. It should be observed, however, that Maedler regarded Alcyone merely as a star situated near the center of the system, and not as a body whose attraction determines the movements of the system. Such an empty center of attraction is yet unknown to us, although we know that the center of attraction may be a mathematical point instead of a body of vast mass.

Lambert himself believed in a dark central sun. In his time the great nebula in Orion was discovered, and Lambert regarded this nebula as a continuous body, luminous only in spots. Let us now examine the nature of Lambert's system, with the omission of the central suns. We can also safely exclude from consideration the systems of the fifth order, consisting of a number of Milky Ways revolving about a common center of attraction. It is possible that other systems analogous to our Milky Way exist and revolve round each other. It was once believed that certain nebulæ, which could not be resolved into separate stars by the most powerful telescope then in existence, represented such systems. One of these was the nebula in Andromeda. Now, however, the prevalent view is that all the nebulæ belong to our own Milky Way, the diameter of which is estimated to



Drive wheels, 68 inches diameter. Truck wheels, 36 inches. Length over all, 65 feet.

CHASSIS OF THE NEW ELECTRIC LOCOMOTIVE.



SECTION TAKEN ACROSS THE PENNSYLVANIA TUNNELS ON THE MANHATTAN SIDE.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

be 20,000 light years, a magnitude of which it is simply impossible to form any conception. Gore infers from certain observations that the nearest external Milky Way must be at least so distant that its light would occupy 100 million years in coming to us. Hence, even if the light could penetrate the great distance between the two systems, which is not certain, no human eye could ever perceive a ray coming from these inconceivable distances.

Hence we may confine our attention to the system of the fourth order, the Milky Way, which we see as a brilliant arch spanning the heavens. It is generally assumed that this appearance of the Milky Way is the result of perspective and is due to the fact that we are situated near the center of the system, which has the form of a double convex lens, so that the stars at the edge of the lens appear more closely aggregated than the others and produce the appearance of a ring. This theory was founded by Wright in the middle of the eighteenth century and it agrees with the views of Kant, Lambert, and Herschel; but, apart from the perspective origin of the apparent form of the Milky Way, the investigations made by various astronomers concerning the distribution of the stars have shown that the Milky Way forms an organic whole with the myriads of fixed stars, star clusters, and nebulæ. The density of aggregation of the stars increases with their approximation to the plane of the Milky Way, but most of the nebulæ are found remote from this plane. Those regions of the sky which are at the greatest angular distance from the plane of the Milky Way are comparatively thinly strewn with stars.

Weight, 166 tons. Horse-power, 4,000. Drawbar pull, 60,000 pounds.

THE NEW PENNSYLVANIA RAILROAD ELECTRIC LOCOMOTIVE.

Lambert's system of the fourth order, therefore, has an actual existence, but, notwithstanding the labors of many astronomers, the laws of its motion have not yet been formulated. With our present methods of observation, it will never be possible to measure the parallax of the most distant stars of the system, because our base line, the diameter of the earth's orbit, is far too small in comparison with these vast distances. The spectroscope gives us valuable information concerning the motions of the stars in the line of sight, but we have a clear notion of the actual movements of only a very few stars. It is a triumph of very recent years that conclusions of the greatest importance have been drawn from this scanty material.

At first view, the fixed stars appear to move in all directions without any regularity, so that Lord Kelvin was justified in comparing the system of the Milky Way to a bubble of gas, in which the molecules move with great velocity, in intersecting paths, in every direction. On this theory the stars, like the molecules of a gas, move in straight lines, from which they are deflected by their mutual approaches, and collisions occur from time to time. The stars are so sparsely disseminated, however, that collisions occur only about once in every 100 million million years. Hence the French mathematician Poincaré regards the system as comparable with the fourth state of matter (Crookes's radiant matter) rather than with an ordinary gas. On this theory it would be difficult to understand why the Milky Way preserves its lenticular form. The researches of Kobold, Kapteyn, Schwarzschild, and others warrant the conclusion that the system is a permanent one and that the entire absence of regularity of motion, which is assumed by Kelvin's hypothesis, cannot represent the facts.

According to Kapteyn's "Two drift hypothesis," the proper motions of the stars, so far as they are known, approximately follow two opposite directions, which lead, respectively, toward the constellations of Aquila and Auriga. In other words, the stars drift in opposite directions, nearly parallel to the line which connects the sun with these two constellations, in the plane of the Milky Way. Great swarms of stars, at immense distances from each other, pursue these common paths, interpenetrate and pass each other, but collisions, as we have seen, are extremely rare because the stars are so sparsely distributed. Recent investigations by Hough and Halm, of the Cape of Good Hope, concerning the motions of more than

ONE OF THE 2,000 HORSE-POWER MOTORS OF THE PENNSYLVANIA ELECTRIC LOCOMOTIVES.

three hundred of the stars of the Southern Hemisphere, in the line of sight, confirm the Two drift hypothesis, although there are some exceptions to the general law. Our sun belongs to a cluster, composed of the nearer and brighter stars, all of which exhibit very similar spectra. Sirius, the brightest star in the heavens, belongs, according to the recent investigations of Hertzsprung, to the system of the stars of the Great Bear, which are known to be moving in parallel paths with a common velocity of 650 million kilometers, or 404 million miles, per year. We do not know whether all these motions are related to a center, or what is the real form of the course of the star drifts, but we have found some order in the apparent chaos of stellar motion. The discovery of this order is the greatest result that has been achieved by astronomy in the twentieth century. Lambert's fanciful system is brought a little nearer to actuality and one day, perhaps, the "Cosmological Letters" will be recalled as the first source of the idea of order in the universe.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

CARBON TETRACHLORIDE.

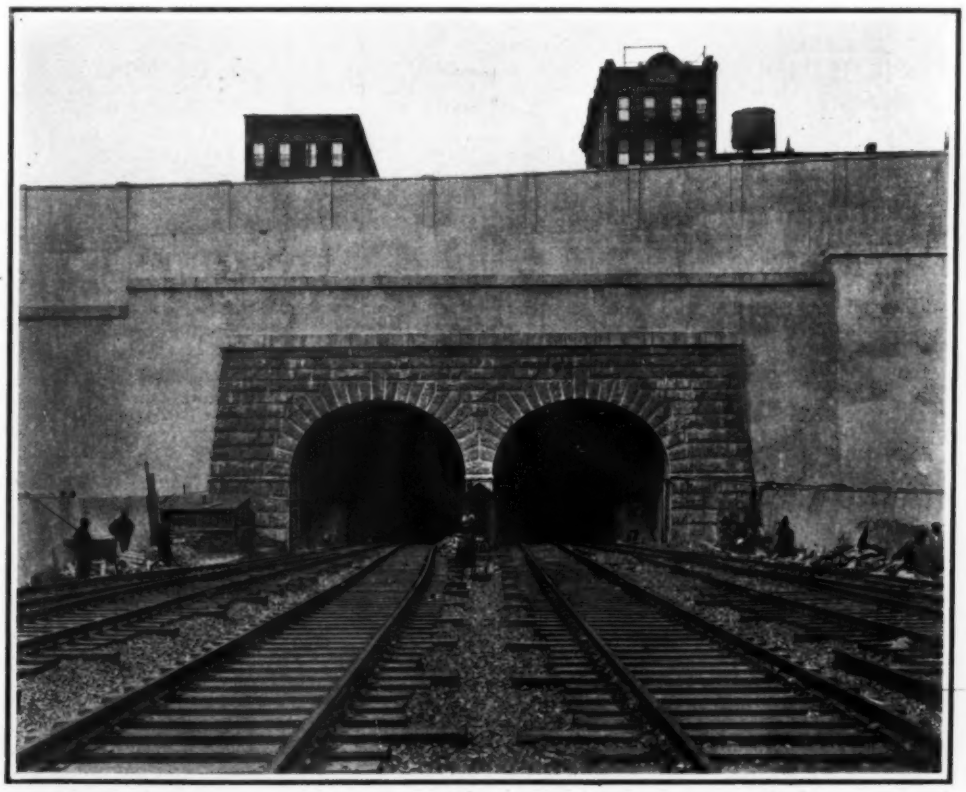
CARBON tetrachloride possesses, in comparison with carbon disulphide, benzine, gasoline and other petroleum products used for the extraction of oils and fats, the advantages of freedom from inflammability, which reduces the danger of fire and the cost of insurance, and of small latent heat of evaporation, facility of condensation, great dissolving power and lack of tendency to form emulsions with fats, all of which properties effect economies in the quantity of solvent or of fuel required.

Oil extracted from seeds by means of carbon tetrachloride does not retain any flavor of the solvent, and the oil cake may be fed to cattle.

The action of tetrachloride on metal vessels is most marked when water is present. The metals least attacked are galvanized iron, copper, cast iron, tinplate, brass, and sheet iron, in the order given. Galvanized iron should be employed in the interior of the apparatus, but copper or lead pipes and bronze cocks may be used.

Carbon tetrachloride is made by several processes in which carbon disulphide is acted upon by chlorine, directly or indirectly. The direct action takes place only at high temperatures and in presence of catalyzers. In the indirect method sulphur chloride or some similar compound is employed.

Cote has devised a process and an apparatus for the continuous production of carbon tetrachloride from chlorine, carbon, and sulphur. Carbon disulphide and sulphur chloride are formed as intermediate products. The apparatus resembles the continuous distilling and rectifying apparatus of modern spirit distilleries. In one vertical cylinder or "column," which is filled with coke impregnated with manganous chloride, carbon disulphide and chlorine come together and form sulphur chloride, with a little carbon tetrachloride. The mixture flows into a second column, filled with coke impregnated with sulphide of iron, where it encounters a fresh stream of carbon disulphide. The resultant product consists of carbon tetrachloride mixed with a little sulphur chloride and containing free sulphur in solution. This mixture passes into a third column filled with metal balls and heated to 260 deg. F. The carbon tetrachloride and sulphur chloride are immediately converted into vapor in which form they pass into the fourth or rectifying column, while the sulphur is melted and flows into an electrically heated furnace, where it combines with carbon to form carbon disul-



NEW YORK PORTALS TO NORTH RIVER TUNNELS.

THE PENNSYLVANIA RAILROAD TERMINAL IN NEW YORK.

phide, which goes directly to the first two columns to recommence the cycle.

From the rectifying column the carbon tetrachloride passes into a vessel where it is distilled, in presence of water, to remove the last traces of sulphur chloride, and thence to a condensing and cooling room.

An electric furnace is employed because the process was devised especially for the utilization of the chlorine evolved in the electrolytic production of soda.

In a radically different method, invented by H. S. Blackmore, of Mount Vernon, U. S. A., carbon tetrachloride is produced by the action of calcium hypochlorite upon calcium carbide and hydrochloric acid. In practice a mixture of 18 parts of chloride of lime and 3 parts of calcium carbide is exposed to the action of a current of hydrochloric acid gas, diluted with nitrogen in order to moderate the intensity of the reaction. The calcium carbide may be replaced by gaseous or vaporized hydrocarbons which should be mixed with the hydrochloric acid gas and directed upon the chloride of line. On the other hand, the chloride of lime may be replaced by other oxidizing agents, or even by oxygen, provided that the operation is conducted at a dull red heat, at which hydrogen exhibits a greater affinity for oxygen than for carbon. Carbon tetrachloride is also produced by the action of the electric arc upon a fused mixture of calcium chloride and wood charcoal. The bromide, iodide and fluoride of carbon can be produced by analogous methods.

MODERN STEREOTYPY.—III.*

THE MECHANICS OF THE NEWSPAPER.

BY HENRY A. WISE WOOD.

Concluded from Supplement No. 1792, Page 294.

SPEAKING generally, the Autoplate consists of a casting mechanism and a series of finishing mechanisms which automatically co-operate in one machine to make the casts and finish them. When used to make plates of the conventional half-inch thickness, its speed is four finished plates a minute; but where the thickness is but a quarter of an inch, from seven to eight plates a minute are easily to be obtained. In the casting mechanism, which occupies one end of the machine, the matrix is placed. The operator by the movement of a lever starts the machine to casting, and this proceeds automatically until the desired number of plates is made and forwarded to the finishing mechanisms. Then, by a reversed motion of the lever, the casting mechanism is brought to rest, when the matrix is exchanged for that of another page. So quickly may this exchange be made that there is lost but the time required to make one cast. Meanwhile, the finishing mechanisms, which run continuously, finish and eject the remaining plates of the previous casting operation. While the machine is at work the matrix is cared for automatically; having been once inserted it requires no further attention until its full quota of plates is cast. Its controlling mechanism is so constructed that the matrix is manipulated with the utmost gentleness and precision; and as many as a hundred casts may be made from a single matrix.

From the casting mechanism the plates go automatically through various finishing operations, and when delivered are ready for the press. These operations consist of sawing off the sprue, which is cast by the Autoplate machine at one of the straight edges of the plate; of sawing a narrow strip from the other straight edge of the plate; of shaving the plate's inner surface to bring the plate to accurate thickness; of accurately dressing the beveled clamping edges and, upon the latest machines, of finally bathing its inner surface to cool the plate, without wetting its printing face. Thus, the entire work of casting, finishing, and cooling the plate is now automatically performed at the rate of eight plates a minute, by a machine which may be run by three men, whose only work consists of supplying its furnace with metal, its casting mechanism with matrices, and of removing the finished plates when ejected by the machine.

By the hand method of plate-making the same amount of work could not have been done by less than 35 men; and even with so large a force the saving of time made possible by the Autoplate could not have been obtained, for eight matrices instead of but one would have been required.

The time saved a newspaper by means of the Autoplate machine may be divided into two parts; that which occurs in the closing of its type-pages which, because of the speed of the Autoplate, may now be held open longer than previously was possible; and that which occurs in starting the presses after the last page is closed. Not only may the first press of a battery be started earlier, but each succeeding press will receive its full complement of plates many minutes ahead of its former starting time. Thus, a large portion of the time that each press formerly spent in waiting for plates is now utilized in producing newspapers, and a great increase of product during the first portion of a run obtained. It is apparent, therefore, that the Autoplate increases the capacity of the composing-room by giving it more time in which to work, and enlarges that of the press-room by making possible the early starting of presses which otherwise would stand idle awaiting their plates; and thus fewer presses need be used. Furthermore, the Autoplate shortens the time between the receipt of news and its publication, and reduces the cost of stereotyping.

The following is a brief technical description of the machine itself. The core, about the lower half of which the plate is cast, is a cylinder having a journal at each end. These, being supported by the housing of the machine, hold the core in a horizontal position. The cylinder is fed with cooling-water, which enters through one journal to spray the upper side of its inner surface, and is siphoned out through the other. The cylindrical core has an intermittently turning movement; for seven-eighths of a complete action of the machine it is stationary, and during the other eighth it is given a half turn and brought to rest. Thus, each of its two semicylindrical surfaces, or faces, is alternately beneath and above. Beneath the cylinder is a co-operating concave part, called the "back," which has a periodical up and down movement of about six inches. When in its uppermost position it embraces the lower half of the core, with space enough between the two in which to cast a plate of the desired thickness. For three-fourths of the machine's cycle of operation the back is in engagement with the core, after which it drops away, to permit the semi-rotation of the cylinder. The back, when casting is not being done, lies at rest in its lowermost position, ready to receive a matrix. At each of the straight sides of the back is a sliding bar carrying a spring-seated matrix-clamp. These bars are secured together and can be moved out or in after the fashion of a drawer. Extending from the back, toward the operator, is a concave continuation of the back, upon the straight edges of which these matrix bars run to their outermost position. This extension is called the loading tray. In it the matrix is laid to be put into the clamps. After the clamps have closed upon it, the clamps and the matrix together are slid into the space intervening between cylinder and back. Then the casting-lever is thrown down, and the parts of the casting mechanism go into operation; when the back, carrying clamps and matrix, closes up beneath the under side of the cylinder, and the matrix is automatically positioned within the circle of the box. Thus, there is provided between core and matrix a semi-circular space equal in length, breadth, and thickness to the size of the plate to be cast. At one of the straight ends of this space, and completely closing it, is the long straight mouth of a pump-spout. Through this spout, rising from a pump which is immersed in a caldron which usually holds 12,000 pounds of molten stereotype metal, the charge of metal is sent immediately into the casting space described the instant the back has formed it. The opposite straight side of the casting chamber having already been closed by the matrix-clamping bar carried at that side by the back, the space is sealed and the charge of metal injected (about 40 pounds) is securely held until it has been cooled by the water-chilled cylinder and back. As the pump plunger is operated by a cam-compressed spring, which continues to apply pressure to the metal in the chamber during its solidification, the shrinkage of the cast is minimized. In the Autoplate machine metal is usually run at 475 deg. Fahrenheit, and a half-inch plate requires about ten seconds in which to solidify. Therefore, after ten seconds of dwell the pump plunger is released, and draws down from the mouth-piece all the molten metal it contains, thus leaving nothing but the cast to be dealt with when the chamber is opened. So sharp is the line at which congelation ceases, an inch above the head of the plate, that after the remaining molten metal has run back into the pump cylinder, and the plate has been ejected, no metal, either in molten or solid form, is left in the mouthpiece to cause clogs, or other difficulties. The cast being hard, the back descends and the matrix-retaining clamps, which are spring-controlled, gently strip the flexible matrix from the plate. This still adheres to the under side of the cylindrical core about which it has been cast. So soon as the stripping of the matrix is finished—a delicate operation, performed with great dexterity and speed by the machine—the cylinder is caused to make its half-revolution, and the plate is brought thereby out of its position beneath the cylinder to that above it and comes to rest. Then the back, with its matrix, once more closes against the under side of the cylinder, the pump acts, and another plate is cast; this time upon the reverse side of the core. Meanwhile the first cast has been lifted from the top of the core and pushed along, upon its straight edges, between two horizontally rotating saws, making 3,500 R.P.M. These remove the narrow sprue cast upon one straight edge of the plate, and the narrower over-cast portion at its other straight edge, and trim the plate at both edges close up to its type surface. After passing the saws the plate goes beneath the dome of a shaving arch, where it comes to rest. Into the smooth inner curve of this it is then lifted and clamped, and a straight, rotating knife promptly smooths out its inner surface ribs, bringing it thereby to proper thickness. As the process of shaving gives the plate not only its thickness, but also the exact curvature of the press-cylinder upon which it is to be clamped, it is most important that it be accurately performed. This is insured by having the parts of great strength and accuracy, and by passing water through the arch-casting. The latter prevents the distortion of the arch, and consequently of the plates, which would occur if the shaving-arch were permitted to accumulate heat, and expand. At each end of the shaving knife is fixed a small hook-like chisel. This reaches over the beveled edge of the plate, made roughly in casting it, and trims the edge close to the type. By this time a second cast has reached the "shaver," as that device is called, and the first plate, being finished, is drawn out by an arm and passed over a wetting apparatus. By means of the latter the plate is given a final cooling, from its inner side only, which leaves the type side dry. The plate, now finished and cold, is ready for press.

The fundamental principles of the Autoplate machine may thus be set forth:

The cast, being made upon the under semi-diameter of a cylindrical core, may be quickly and easily ejected by a half-turn of the core. This arrangement permits of a double speed in casting, as two core surfaces are alternately used—the one having opportunity to cool while the other is in use. It further provides two natural postures for the work of casting and delivering the plate. Thus the plate is cast with its printing surface beneath, which insures a good face; and upon its ejection from the casting chamber is left face up, resting upon its two straight edges, in position to be most easily mechanipulated.* Moreover, as the operation of casting the plate occupies but the under part of the core, and that of delivering it from the core occupies only its upper part, both functions may simultaneously take place. This greatly increases the celerity with which the machine may be worked.

The matrix is mechanipulated: the mechanism used for the purpose acting with a gentle, uniform motion, to position the matrix with accuracy for each cast to be made, and to strip it from the resulting cast without injury of its delicate texture. Thus as many as one hundred casts have been made from one matrix.

Several safety appliances are embodied in the machine. One consists of a stud with a V-shaped nick which is cut to surround its middle portion. This stud, being inserted in a hole common to two adjacent elements of the driving mechanism, serves to communicate from one to the other the power furnished to drive the machine. As the nicked portion of the stud lies at the point of juncture of these elements and its nicked section is of sufficient strength to transmit the necessary power, it will serve under normal conditions to drive the machine. But as the nicked section of the safety pin, as this is called, is weaker than the weakest part of the machine, it will instantly give way if the machine be obstructed, and the machine will then come at once to rest. The obstruction hav-

* Read before the Franklin Institute.

* In my experience, I have frequently felt the need of a word which should express the "handling" of its work by a machine, as the word *manipulate* expresses the handling of the work of a man by his hands. To fill the gap I have made bold to coin and use the word *mechanipulate*, which is here employed.

ing been removed and another pin inserted, work may immediately be resumed. As Autoplate machines were to be used by workmen unskilled in the care and use of automatic machinery such a safety device became necessary. Error-preventing appliances, also, are employed. By means of these it is not possible, for instance, to insert the matrix-clamping mechanism in the casting chamber unless, the matrix being inserted, all its parts are in proper position; nor is it possible to start the casting mechanism to work until the matrix-clamping device is safely and properly positioned in the casting chamber. During operation the matrix device cannot be withdrawn from the chamber, for in order that it may be withdrawn casting must first cease. While the casting chamber is open, and the matrix parts are out of position, the pumping system is under restraint, so molten metal cannot, by any carelessness of a workman, be ejected. The Autoplate machine has so successfully been made "foolproof" that a mishap is an extremely rare occurrence.

Autoplate machines cost $25,000 each. The New York Herald has three, the New York World four, the New York Times two, the Chicago Daily News four, and the Tribune of Chicago three. Other large newspapers throughout America, Great Britain, and Europe, also, have them in use. Many instances of pay-roll savings, ranging from $30,000 to $40,000 a year, may be set to the credit of this machine; while in the saving of time, a still more valuable consideration, some surprising results have been achieved. One of the largest New York daily newspapers, for instance, is now closing its type-pages twenty minutes later than it formerly could, and whereas its whole battery of presses used to require an hour in which to be set to printing, it is now got to work in less than fifteen minutes. The gain of this particular newspaper may be summarized as: a yearly saving of over $40,000 in wages; twenty minutes of added time in which to gather news and advertisements; and the ability to get all of its presses running some forty minutes earlier than formerly, which enables it to catch earlier and more trains and thus vastly to extend the area over which it circulates. In addition to these advantages this newspaper has been able to increase its selling time on the street, and greatly to improve its typographic appearance.

Coincident with the adoption of the Autoplate machine by the dailies of the larger cities there arose a demand, from newspapers of lesser magnitude, for a similar machine suitable to their needs. This was supplied in the Junior Autoplate, a very much less expensive apparatus, but one built upon Autoplate principles. Several functions, in the parent machine automatically performed, in the Junior Autoplate were assigned to attending workmen. The cylindrical core was stood on end and, with the back, which was similarly positioned, was given additional length to provide a sprue of sufficient height to insure the pressure necessary for perfect casting. In this machine the casting space was left open at its upper—its curved —end and was filled from an over-hanging spout by means of a hand-worked pump, immersed in a 10,000-pound pot of molten metal. The back was moved to and from the core by a hand-worked lever, and after the cast had cooled and the back had been drawn away, the operation of a hand-worked clutch-lever set the cylinder to making a half-turn, by power. As in this case the plate was "poured" at one of its curved ends, its straight sides required no subsequent sawing; nor did they require hand-dressing, because of the fact that the matrix-edges and the clamps were made of such shape that all protrusions at the straight-edges, save only the type itself, were cast below printing height. But the riser, which constituted the upper curved portion of the cast, as in the case of a hand-made plate, had to be removed. This was done during the half-turn of the cylindrical core which turned the cast out of the casting chamber. Two saws were then thrown into position ahead of the plate, one at the height of the upper edge of the printing plate itself, and the other opposite its lower beveled edge. As the cast passed these saws one severed the sprue from the plate while the other trimmed its lower edge. Small pockets in the cylinder surface, into which the metal of the cast had run, acted during the sawing operation to hold the sprue and the plate securely to the cylinder, where these continued to cling after they had been sawn apart. The cylinder having come to a stop, the back, with the matrix, was again closed upon its rearmost side, and another charge of metal thrown into the casting chamber. While this was being cooled by the water-circulation of cylinder and the back, the workman removed the first sprue and, after tossing it into the pot, removed the first cast. This he dropped into the old, conventional shaving device, and planed it out in the usual way. After having been shaved, dipped, and dried by hand the plate was then ready for use. The freeing of the sprue and cast from the cylindrical core, it should be remarked, was accomplished by means of a slight blow delivered by the straight edges of the back when closed for a succeeding cast. Thus freed from the core the plate was left standing upon a shelf, upon its lowermost curved edge, whence it was removed by hand. The sprue, still held to the cylinder by a couple of pins, from which it hung, was easily removable by hand. Two unusual engineering practices were necessary in this machine. The saws, making 4,000 R.P.M., had to be driven to cut in the same direction as the cast moved. This was done so that their dust should not be thrown into the casting-chamber to prevent its making a tight joint at closing. The upper saw had to be set to cut directly against the iron of the cylinder. Both were successfully accomplished, and have since worked without trouble. But one further feature of the Junior Autoplate machine need be mentioned—the device employed to inform the workman when to open the casting chamber. In hand casting it is left to the operator to determine just when the cast is sufficiently hard to be removed. Thus, much time is unnecessarily lost. It was to save this waste of time that an announcing mechanism was applied to the Junior. It consisted of a gong and a slowly driven toothed wheel, by a notch of which a spring-pressed clapper could be engaged and cocked. A cam-like piece secured to the framing, but adjustable about the center of the wheel, was provided to trip the spring-pressed clapper at any given point which might be chosen, and permit it to fly back and strike the gong. Thus, if the tripping-cam were set at a point to reach which it required the notch of the wheel that held the clapper-level ten seconds of time, the gong would be sounded ten seconds after the clapper had been thrown into engagement with that notch. From the handle of the pumping mechanism used to fill the casting chamber depended a finger, which acted to cock the clapper at the moment the pouring stroke of the pump lever occurred. By this arrangement the gong, if its cam were adjusted to allow the normal time required to cool a cast, made from metal at a given temperature, could be depended upon accurately to announce the arrival of the moment at which the cast should be removed. To set this device it required merely a knowledge of the speed with which the particular metal used solidified.

In the Junior Autoplate, it will be observed, the fundamental principles of the Autoplate machine recur: the matrix is stripped and repositioned without the intervention of the eyes or hands of the workman; casts are successively made upon alternate sides of a cylindrical core; a half-turn of the core simultaneously ejects a cast and presents a fresh casting-surface; and the closing of the chamber frees the preceding cast from the core so that it may thereafter be removed during the succeeding casting operation. In the Junior Autoplate, however, a new principle, among other, minor ones, is to be found: the cast is cut from its sprue while both are attached to the core, by means of a saw working in conjunction with the latter. The rate of production of the Junior Autoplate machine is three plates a minute. Its plates, however, as delivered by the machine, are not wholly finished, but require thereafter to be shaved, dipped, and dried.

In many instances newspapers have purchased not one but several Junior Autoplate machines. This has led to the construction of the double Junior, which consists of two Junior Autoplate attached to an elliptical pot, one at each of its ends. The pot employed is usually of 16,000 pounds capacity. The machines are made right and left, and are independent of one another. Such an equipment requires the use of two matrices, one for each machine, and its rate of production is six plates a minute.

Having finished the construction of the double Junior Autoplate, a new apparatus called the Autoshaver was next provided, to shave, cool, and deliver, dry, the plates made by Junior machines. This consisted of an inclined run-way of stud-supported, flanged wheels, along which the plate might run by gravity, upon its straight edges. At the upper end of this run-way was a receiving station, its exit barred by a cam-worked gate. Next along the route of the plate came a shaving arch, it also having at its lower end a cam-worked gate; then below the shaving arch a water-saddle, the exit of which was likewise barred, and, finally, beyond this a receiving station beneath which rotated a brush to clear the plate of such water as might adhere to its under side. Driven by the operating mechanism of the machine were cams, which worked the gates, a constantly rotating shaving knife within the arch, clamps for therein securing the plate and the brush. The shaving arch was cooled as in the Autoplate by the circulation of water, which went thence to the water-saddle. There, over a series of riffles, the water broke into a cascade so arranged as to compel it to contact with the inner side of the plate, which it cooled. The Autoshaver made six revolutions a minute, and was capable of receiving a plate at each revolution. To use it, it was only necessary that a plate from a Junior should be placed and left on the receiving stand, with its straight edges on the wheels of the run-way. At the proper moment the first gate opened and let the plate run into the arch, where the second gate arrested it. There it was clamped and shaved, and at the proper moment released to run out and onto the water-saddle. After having been there held for an instant, and cooled, it was released by the last gate, and ran forward to the delivery stand where, being brought to rest by a stationary stop, it was brushed out, and thereafter stood ready to be sent to press. Having a capacity of six plates a minute the Autoshaver was capable of finishing the product of a double Junior Autoplate machine. Thus, it has become the custom to install with every double machine, an Autoshaver. The New York American, for instance, uses three such equipments, having a combined capacity of eighteen finished plates a minute. In this newspaper office its Autoshavers are so arranged that their finished plates are taken from them by automatic carriers to the various press-rooms in which they are to be used. Thus, a stereotyper touches a plate but once, in transporting it from Junior to Autoshaver.

In concluding the subject of the evening, it may lend a touch of human interest to what has been of necessity but a dry relation of mechanical facts, if I state that nearly $2,000,000 worth of Autoplate machinery has been sold at home and abroad; and that it has been carefully computed that in the United States and Canada there is now being made by its use a yearly saving of over $350,000.

THE EFFECT OF WATER UNDER PRESSURE ON TRANSPLANTED TREES

THE growth of transplanted trees is often greatly retarded, if not entirely checked, by the desiccation which the trees have experienced in the course of their removal from the nursery to their final sites. For this reason the agricultural experiment station of Wisconsin has been trying the effect of restoring to the tree the water lost by evaporation, by applying water to the roots under slight pressure. In order to carry out this plan it is necessary to have a certain quantity of water supported at the level of the top of the tree and placed in communication with a root by means of a tube, so that the pressure exerted by the column of water can be transmitted to the sap vessels. The apparatus used is very simple, consisting of a small vessel attached to a piece of gas pipe, which is closed at the bottom. The root is connected with the gas pipe by means of a rubber tube and a lateral tubulure. At the moment of application one of the large roots is laid bare, and the apparatus is set up at such a distance that the rubber tube can be easily connected with the root, where it is made fast by tying. The vessel is then filled with water, which is absorbed more or less rapidly, according to the condition of the tree. The effect of the operation is often perceptible within forty-eight hours. A beech trees transplanted in April was subjected to the treatment some time in May, when it had given no indication of life. Six days afterward the buds opened and the leaves appeared. Similar results were obtained with plum trees, but the most striking result was obtained with seedling apple trees. Twenty of these trees had been used during the winter by the students in practice in transplantation, and had consequently been exposed to many variations of temperature and moisture. In the spring all of these trees were planted in the same manner, and in the same soil, and half of them received the hydraulic treatment. A week after the treatment, the trees which had received it began to open their buds, and two weeks later they were in full leaf. During this time only one of the untreated trees had shown any indication of growth. It should be observed, however, that in autumn all of the trees, with the exception of two of the untreated trees which had died, had made substantially equal growth. Hence the benefit produced by the water treatment appears to be confined to rousing dormant life and accelerating initial growth.

This treatment, which has been known since 1897, is indicated whenever young trees have been made unusually torpid by freezing or drying, and when it is desired to transplant trees without cutting them back. —La Nature.

The Electrical Engineer gives the following particulars relating to some of the latest improvements in the Berlin electric railways. The driver's cab now forms part of the guard's van, and the guard's seat is opposite a window looking into the cab, so that each can co-operate fully with the other. If by any chance a train passes a danger signal, its brakes are automatically applied by means of contacts in the permanent way, which actuate the brakes by means of an apparatus on the roofs of the coaches, while at the same time a signal appears in the van showing what has taken place. If signals are overrun at the junction, danger signals—stopping any train which might collide with the first—are automatically exhibited.

HALLEY'S COMET AND THE TALMUD.

IT can hardly be disputed that the honor of having been the first to place cometary theories upon a scientific and mathematical basis belongs to Halley, who, inspired by the labors of his friend Newton, subjected comets to the law of universal gravitation and thus forever dispelled the mystery with which comets had been hedged before his time. A writer in Revue Générale des Sciences Pures et Appliquées wonders whether it would not be of interest to ascertain if before him any scientist had thought of the periodicity of comets. In studying certain passages of the Talmud he believes to have discovered evidence that the ancient observers of Palestine suspected the periodicity of some comets at least. Here for example is the textual translation of a fragment which seems to the author in question to apply to Halley's comet.

"Two wise men of Palestine, Gambiel and Joshua, together made a voyage on the sea. The first had brought with him bread to eat. The second one in addition had brought flour. When Gambiel had eaten all his bread he asked his companion for flour and said to him: 'How didst thou know that we should be so long time on our journey that thou didst provide thyself with flour?' To which Joshua did answer: 'There is a very bright star which appeareth every seventy years, and which deceiveth mariners. I have thought that perchance it might surprise us during our voyage, lead us astray, and thus prolong our voyage on the sea. Hence it is that I have provided myself with flour.'"

The difference in the period indicated (70 years) and the actual period of Halley's comet (75 to 79 years) is easily explained by the fact that in ancient Hebrew texts figures are usually given in round numbers. It is not at all surprising, therefore, that Asiatic astronomers should have placed the period of cometary revolution at 70, a number sacred among the Hebrews.

The star referred to may have been the apparition of the year 66. Indeed, Gambiel II., one of those who figure in the narrative, was born in the first half of the first century of our era, and was *Nassi*, or supreme head of the Jews, from the year 90 to the year 110, in the school of Jabneh, a town of Palestine situated on the shores of the Mediterranean between Jaffa and Asdod. This school, in which religious problems were studied and commentaries evolved which later were joined to form the Talmud, was founded by Iochanan ben Sakkai after the destruction of the temple of Jerusalem in 70 A. D. Gambiel was a learned man. Besides his mother tongue he spoke Greek and Latin, and was well versed in astronomy, as well as his friend Joshua, less known than he. The nearness of the sea facilitated numerous voyages, which they often took together either for commercial or other purposes.

In the year 95 Gambiel went to Rome to intercede with the Emperor Flavius Clemens in favor of certain coreligionists. These details would seem to show that the legend is based upon historical fact.

The question now arises as to whether this star, which appeared every 70 years, really was a comet. There can hardly be any doubt of that, for there is no variable star of so long a period. We should be compelled to assume that a variable star had arrived at its last stage of stellar life after slowly fluctuating in brightness through vast spaces of time and was eventually extinguished, or at least so diminished in brightness in the interval of eighteen centuries, that no appreciable change could be detected by a modern observer. This is hardly likely. The hypothesis of a periodic comet seems most logical, and receives support from the greatest of the old Talmud commentators, the celebrated Raschi, who lived in France from 1040 to 1145. "The ancient navigators," said he, "were guided by the stars only. They knew the certain positions for certain constellations in the heavens at different times of the year. They knew which group should lie to their left and which should lie to their right in voyaging from port to port. It is conceivable that the appearance of a bright star moving rapidly among the stars and visible sometimes in the north and sometimes in the south would in their minds disturb the harmony of the constellations and possibly lead them in error."

If one seeks to identify the apparition, about which Joshua and Gambiel conversed, with one of the comets mentioned in historical and astronomical annals, Halley's comet alone would seem to fit the necessary conditions, particularly in the light of the foregoing explanation of Hebraic periods. Assuming that Asiatic astronomers of the first century of the Christian era suspected the periodicity of this famous celestial wanderer, it must be admitted that some of its previous apparitions were carefully observed. The apparition immediately preceding that referred to occurred in the year 12 before our era (perihelion passage October 8th). On the other hand, Crommelin has identified Halley's comet with apparitions of the years 87 163, 240, and 467 B. C.

TRADE NOTES AND FORMULÆ.

Process of Producing Silver Tincture from Fish Scales (according to a new method, recently patented in Germany).—Hitherto the so-called silver tincture has been made by dissolving the glittering substance from fish scales in water. This so-called pearl essence was mixed with gelatine and applied in a warm condition. Such a tincture is not adaptable for flexible objects because the coating, on account of the gelatine it contains, cracks off on bending. Moreover, it cannot be applied at all by spraying and only with considerable difficulty by means of a brush. All these objections are supposed to disappear in the product made according to the invention in question. The claims of the patentee are as follows: Process of making silver tincture from fish scales, consisting in that the shining substance of the fish scales, dissolved off in water, freed from water by water-expelling fluids, miscible with varnishes, and without previous drying, is mixed with an elastic varnish, for instance, celluloid varnish.

The Manufacture of Patent Leather.—Of a good leather varnish it is required that it will intimately adhere to the fibers of the leather, that it will dry well, be flexible when cold, and in addition to this waterproof. To impart these properties to the varnish perfectly purified linseed oil, known as varnish linseed oil, must be used, which has been freed from palmitine by treatment with fuming nitric acid. The linseed oil used for the preparation of the varnish must have been long in storage, which is recognizable in its perfect yellow color and transparency, whereas new oil has a greenish and turbid appearance and contains more water than old oil. The oil is first heated in an iron kettle at 150 deg. C. until the formation of foam ceases, then heated to 250 deg. C., when it will assume a bluish green color; any fibrous, tough particles separated should be carefully skimmed off. Next day the oil is quickly heated to 350 deg. C. and kept at this temperature for six hours, which usually results in a sufficient concentration which may be recognized by the rapid drying of a sample on a glass plate and in its hard and glossy character. When, besides, a sample applied to paper produces no grease spot, the oil is quickly cooled to 150 deg. C. and then 3 per cent of litharge or 1.5 per cent of borate of manganese added. To obtain brilliancy and hardness, at a temperature of 250 deg. C., 5 per cent of brown umber or 10 per cent of Angola or Kauri copal is added. After the addition of lamp black or diamond black, the foundation color is applied to the grained side and the dried surface polished smooth with pumice stone, then the black coat is applied, and after this has been dried in an oven at 40 deg. to 50 deg. C. in some dust-free place the last varnish coat is applied by means of a horse-hair brush or the varnish spray.

Porcelain Cameos.—First a frit is prepared; 25 parts white quartz sand, 16 parts white potash, and 8 parts soda, crushed, sifted, and well mixed in a bowl, well lined with thoroughly beaten sand, and placed on the hearth of a faience kiln. Take the frit from the kiln, clean it, crush it, and grind it in a faience mill, with stones of sandstone. To 2 parts of ground frit, take 1 part of porcelain mass (previously washed in the usual manner). Blue color for cameos: 50 parts of cameo mass, 2½ parts washed porcelain clay, and 5½ parts of cobalt blue. (The latter prepared from half a part of cobalt, previously crushed and sifted, exposed in a crucible, half buried in sand, to the heat of a hot faience kiln fire, crushed, sifted, and to 2 parts 1 part of frit added and returned to the kiln.) Preparing the cameos: An annular copper mold is evenly filled with white cameo mass, white paper and felt disks, placed above and below, and the whole put in a press. Take it out, remove the felt disks, apply the cobalt blue, replace the disks, and return to the press. Take it out, place between wet cloths and keep it in a damp place. To produce the cameo: A copper plate, on which the desired design is engraved, in the form of a seal, is rubbed with oil or spirits of turpentine, the engraved places filled with white cameo mass and placed over the above-described form, filled with blue covered mass. The whole placed in the press. After pressing and removal of the copper plate, it is fired in a faience kiln.

Asphalt Cable Mass.—This substance is employed for filling out cable sockets and pipes, for which purpose refined bitumen is used, or, owing to their smaller cost, commoner substances, such as plaster, clay, etc., mixed with it. Ozokerite and Chatterton compound are also employed for this purpose, the latter a mixture of 65 parts gutta percha, 18 parts of wood tar, and 25 parts of rosin. As a suitable cable-mass, that is, for the insulating or non-conducting impregnation of cables, black cable-mass is employed, with tar and asphalt as constituents. Also purified bitumen, after it has been vulcanized by the admixture of 5 to 20 per cent of sulphur generally carefully prepared and made elastic, so that when the cable bends it will not break. Heated Chatterton compound is also extensively employed in order that, in cable making, a close contact of the gutta percha will be obtained.

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SCIENCE NOTES.

The radio-activity of potassium salts has been investigated by J. C. McLennan. The method adopted is the following: One vessel is placed within and insulated from a second, and the electrical charge which the insulated vessel more or less rapidly acquires is then observed. Preliminary experiments were made on the charging action of the radiation from polonium, and that of the secondary rays excited in Al by the γ-rays from Ra; the charges acquired by Ur salts at low pressures were also observed. In the case of potassium salts the results show that in high vacua both potassium nitrate and potassium sulphate emit an excess of charged particles of the β-type. The effect observed in all cases was small and it required exceptional conditions to bring it into evidence. It was not found possible to decide whether any radiation of the α-type is emitted by the potassium salts or not.

H. Siedentopf calls attention to a new step in ultramicroscopy in the proceedings of the Deutsch. Phys. Gesell. After recounting the optional conditions necessary to make ultramicroscopical particles visible, he describes a new luminous ultramicroscope and its manipulation. Complete "dark field illumination," i. e., illumination round the edge of a central screen or stop, is attained by means of two dark field condensers, the paraboloid or the cardioid condenser. The aplanatism of the latter depends on a remarkable, hitherto unknown property of the cardioid. The efficiency of the new appartus is due, in addition, to special quartz chambers and new objectives. Work with the instrument is described, including new observations on the Brownian movement, on the shape of ultramicroscopic metal particles, on microchemical reactions and light reactions. The reduction of white silver bromide in water to polychrome silver particles resembling a Lumière autochrome plate is also described with the aid of colored drawings.

The invention of spectacles is usually assigned to the end of the thirteenth century, but Gaudin and Regnault have recently made a communication to the French Society of Anthropology which, if it is confirmed, will carry back the invention to a much earlier date. These scientists, in fact, have presented to the society a pair of spectacles which they claim to have found in the excavations at Smyrna. According to the description of the drawing submitted, these spectacles are of peculiar form; each glass is mounted separately and the two mountings are connected by a movable joint, so that one can be folded upon the other. Each mounting is circular and is provided with a groove for the reception of the edge of the circular lens. One of the lenses, greatly corroded, is still in place. It is a double convex about 1.4 inch in diameter. The ring of metal which forms the mounting is not complete; but leaves about ⅞ inch of the glass exposed and acts like a spring. It can be opened for the insertion of the lens, and its elasticity then holds the lens in place. It should be added that these spectacles were not found *in situ* and consequently it is uncertain whether they belong to the Greek or the Byzantine period. There can be no question that they are very ancient, but it is evident that the value of this discovery is at present only provisional.

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